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Volume 26 Number 24

Abstracts 58495-60848

December 31, 1972

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Volume 26, Number 24, December 31, 1972

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Each author's name is indexed in the form appearing on the document abstracted:

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TRITIUM
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  content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
  determination in luminescent material by scintillation ccunting, 25:40 (IDO-12073, pp 28-36)

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372 (UCRL–72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009–1). Dep. NTIS.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 59219, 59220, 59270, and 59351.

Activation and Nuclear Reaction Procedures

Refer also to abstracts 58817, 58820, 58884, and 59043.

58495 (AE-458) ACCURACY AND PRECISION STUDIES OF A RADIOCHEMICAL MULTIELEMENT METHOD FOR ACTIVATION ANALYSIS IN THE FIELD OF LIFE SCIENCES. Samsahl, K. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Aug 1972. 18p. Dep. NTIS (U. S. Sales Only).

The reliability of a fully automated group-separation method was studied. The accuracy and precision of the pure radiochemical processing were determined for 30 elements frequently found in biological material or soil solutions. The results were compared with the counting statistics obtained for many elements in neutron activation analysis of the International Biological Standard and human blood serum. The comparison showed that the precision of the radiochemical method is for most elements higher than the corresponding one obtained in the counting operations. This applies also for many elements that could be measured interference-free in the practical example, i.e., without a lowered sensitivity owing to underlying activities of other elements in the same groups. The relative standard deviation of a single value (at the 68% confidence level) for the group-separation method varied between 0.4 and 3.6%, and the radiochemical yield was better than 95% for 25 elements. The advantage of using NaI scintillation counting on a large number of separated groups, instead of Ge(Li) spectrometry on a reduced version of the radiochemical method was demonstrated with the International Biological Standard. (auth)

58496 (DP-MS-72-38) MULTI-ELEMENT NEUTRON ACTIVATION ANALYSIS OF SEDIMENT USING A ^{252}Cf SOURCE. Hayes, D. W.; Peterson, S. F. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 11 Sep 1972. Contract AT(07-2)-1. 5p. (CONF-720902-4). Dep. NTIS.

From National topical meeting on the applications of californium-252; Austin, TX. (11 Sep 1972).

The application of a ^{252}Cf source to the neutron activation analysis of several elements (Mn, Al, Ca, Na, Cl, and V) in small (~1.5 inch in diameter) cores was studied using high-resolution gamma spectroscopy and manual data reduction. (auth)

58497 (NYO-3417-19) PROGRESS REPORT [ON CHEMISTRY], JUNE 1, 1971-MAY 31, 1972. Finston, Harmon L. (Brooklyn Coll., N. Y. Dept. of Chemistry). 1972. Contract AT(11-1)-3126. 11p. Dep. NTIS.

Manganese metal powder samples were irradiated in the HFBR for 5 days and the ^{54}Mn and ^{59}Mn spectra studied. Similar studies were conducted with yttrium wire, but neither of the two prominent gamma rays of 108-day ^{88}Y were detected. Gamma spectra of indium-115m and indium-116 produced by irradiation of indium by a nonmoderated Be-Pu source are given. Freeze-dried fish flesh, liver, and algae were analyzed for Hg by thermal neutron activation. The effects of chloride ions on the mechanism for synergic solvent extraction in the system Fe(III)-TOPO-TTA were studied. Studies were also conducted on the extraction of Fe(III) using chlorendic acid. (J.G.B.)

58498 14 MeV NEUTRON ACTIVATION ANALYSIS OF OXYGEN IN ORGANIC SUBSTANCES BY THE USE OF A DILUTION TECHNIQUE WITH SOLID PARAFFIN. Yabe, Katsumasa; Ueda, Shigeru; Hasegawa, Yoshihisa; Sato, Toshio (Government Industrial Development Lab., Hokkaido, Japan). Radioisotopes (Tokyo); 21: No. 2, 80-5(Feb 1972). (In Japanese).

The investigation was carried out to find a proper sample preparation and a proper standard material for accurate determination of oxygen in organic substances by fast neutron activation analysis, wherein a serious systematic error due to β self-absorption is always a problem. The error mainly depends on the difference in density between a sample and a standard material and it is effectively eliminated by using a mixture of stearic acid and solid paraffin as a standard and also diluting the sample with solid paraffin. For most of organic samples, eight times dilution was found to be enough to lower the relative systematic error down to 2%. (auth)

58499 ANALYSIS OF POLYMETALLIC ORES AND PROCESSING PRODUCTS WITH THE USE OF A NEUTRON GENERATOR. Muminov, V. A.; Navalikhin, L. V.; Talanin, Yu. N. (Inst. of Nuclear Physics, Tashkent). Zh. Anal. Khim.; 27: No. 7, 1416-19(Jul 1972). (In Russian).

A method was developed for determining Pb, Cu, and Zn in samples of polymetallic ores and products of their processing after one irradiation. A method is suggested for measuring the activity of a mixture of two (or more) radioactive isotopes that differ only by their half-life periods. The sensitivity of determining lead is (1 to 2) × 10^{-1}%, for copper and zinc it is (3 to 5) × 10^{-2}%. (auth)

58500 NEUTRON ACTIVATION ANALYSIS OF MERCURY IN FISH, FLOUR, AND STANDARD REFERENCE ORCHARD LEAVES BY ELECTRODEPOSITION RADIOCHEMISTRY. Heitzman, M. W.; Simpson, R. E. (Food and Drug Administration, Washington, D. C.). J. Ass. Offic. Anal. Chem.; 55: No. 5, 960-5(Sep 1972).

A method for neutron activation analysis of mercury is described in which electrodeposition is used to isolate the mercury carrier in the recovery step. Although the recovery of mercury carrier is variable, the results yielded by this technique are comparable to those obtained using sulfide precipitation in neutron activation analysis. The method was also compared to gas chromatography and atomic absorption techniques and similar results were obtained. No interferences were evident in the samples analyzed: fish, flour, and standard orchard leaves. The method can detect ppB levels of mercury. (auth)

58501 NONDESTRUCTIVE ANALYSIS OF SILICON AND OXYGEN ABUNDANCES IN THE LUNA 16/078 POWDER SAMPLE ACTIVATED WITH 14-MeV NEUTRONS. Nagy, A.; Csoke, A.; Bakos, L.; Szabo, E. (Central Research Inst. for Physics, Budapest). Radiochem. Radioanal. Lett.; 11: No. 5, 321-9(10 Oct 1972).

The abundances of silicon and oxygen in a powdered lunar soil sample, labeled 16/078, brought to the Earth by the Luna 16 mission determined by 14-MeV neutron activation analysis were found to be 20.6 ± 2.0 and 42.1 ± 1.2 wt %, respectively. (auth)

58502 EFFECT OF THE GEOMETRIC CHARACTERISTICS OF THE SYSTEM ON THE SENSITIVITY OF THE AUTORADIOGRAPHY METHOD. Merkulov, M. F.; Kortukov, E. V.; Kortukova, V. M. (Kuban State Medical Inst., USSR). Zh. Nauch. Prikl. Fotogr. Kinematogr.; 17: No. 4, 245-50(1972). (In Russian).

Various microstructures may be investigated by means of autoradiography with great precision. The possibility of determining the geometric efficiency while using point and line sources was examined. Shielding coefficients for various Ag halide microcrystals located close to a source were tabulated, and could be used in calculating shielding coefficients for densely packed Ag halide grains at various depths of the source. The geometric probability of activation of Ag halide crystals was calculated for the impact of a β particle with the kth crystal. Thus, the sensitivity of the autoradiographic method depends on the yield of developed grains from one incident electron from the source, and on the geometric efficiency of the system. (2 figures, 2 tables) (K.S.W.)

58503 RAPID NEUTRON-ACTIVATION METHOD FOR THE SIMULTANEOUS DETERMINATION OF ARSENIC AND ANTIMONY IN ROCKS. Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). Analyst; 97: No. 1153, 241-4(Apr 1972).

A simple, rapid, radiochemical neutron activation method for the determination of arsenic and antimony in rocks is described. After fusion with alkali and separation of the insoluble hydroxides, arsenic and antimony are determined in the filtrate and in the hydroxide fraction, respectively, by a single precipitation of the sulphides after acidifying each fraction with hydrochloric acid. Chemical yields are determined by re-activation. The precision of the method is high for both elements, as demonstrated by the analysis of some standard rocks, and the sensitivity is adequate for most geochemical studies. (auth)

58504 ACTIVATION ANALYSIS FOR LANTHANUM AND SCANDIUM WITHOUT DESTRUCTION OF THE SAMPLE. Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 1, 100-1(1972). (In Russian).

The conversion of ^{139}La by thermal neutrons to ^{140}La with a 1.6-MeV γ ($T_{1/2}$ = 40.2 hr) is the basis for a recommended procedure for determining La in a sample. Similarly, spectral peaks for ^{46}Sc appear at 0.89 and 1.12 MeV, which are conveniently located for simultaneous determination of Sc and La in the same sample. (K.S.W.)

58505 DETERMINATION OF MICRO-IMPURITIES IN NATURAL DIAMONDS BY AN ACTIVATION METHOD. Mirzaev, M. R.; Khabirov, N. A. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 1, 91-3(1972). (In Russian).

Natural crystalline diamonds weighing 60 to 100 mg were irradiated with a thermal flux of 1.2×10^{12} neutrons/cm^2 · sec for 3 min. Standards were simultaneously irradiated. A tabular description of diamond colors and other characteristics of the samples is presented with the corresponding amounts of the following impurities: Al, Cu, Mn, Na, Au, Co, Cr, and Sc. Consistently present in all diamond samples tested were: Al, Cu, Mn. (K.S.W.)

58506 SODIUM AND POTASSIUM LOSSES DURING CALCINATION IN CONNECTION WITH RADIOACTIVATION ANALYSES OF BIOLOGICAL MATERIAL. Abdullaev, Ya. S.; Khatamov, Sh.; Kist, A. A. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 69-72(1972). (In Russian).

Ashing of residues is familiar to many biological assays, and uncontrolled losses were observed by a number of workers. The dynamics of the losses of Na and K were studied by ashing ground mulberry leaves at various temperatures and for various periods of time, in closed vessels, and in atmospheres of Ar or N_2. The Na and K were then determined by neutron activation. The presence of air, Ar, or N_2, alternatively did not alter the results. In the temperature interval commonly recommended for ashing biological materials, Na and K contents are adequately stable although amounting to 70 and 45%, respectively, of the original amounts. At considerably higher temperatures Na does not change and K decreases to 10% or less of the original. These data are discussed in the light of other experience. (K.S.W.)

58507 RAPID TUNGSTEN DETERMINATION BY NEUTRON ACTIVATION USING THE ACTIVITY OF ^{183m}W AND A LINEAR ELECTRON ACCELERATOR. Abbosov, O.; Abrams, I. A.; Babaev, A.; Pelekis, L. L.; Starchik, L. P. (Physical-Technical Inst., Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 15: No. 4, 18-21(1972). (In Russian).

The short-lived isotope ^{183m}W was the basis of this rapid W assay by neutron activation, wherein the neutron source was the (γ,n) reaction generated by bremsstrahlung from a linear accelerator (5-MeV electrons in a current of 1 mA). The target for the electrons was a water-cooled Pt plate; the target for the bremsstrahlung was a 2-kg Be mass. A 20-sec exposure time for the sample containing W was insufficient to activate such impurities as Mn, Na, and K; however Mo, Cu, Ba, and Al produce short-lived isotopes by neutron activation which contribute sufficient γ radiation to correspond to about 0.15% W, and this amount is within the limits of error of the determination. (K.S.W.)

Chemical and Spectral Procedures

58508 (CEA-CONF-2015) AUTOMATION IN MOLECULAR ABSORPTION SPECTROPHOTOMETRY. Houin, C. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). 1970. 5p. (CONF-701153-1). Dep. NTIS (U. S. Sales Only).

From fifth technicon international congress; New York, NY. (2 Nov 1970).

In the control of uranium manufacturing processes, automation was applied to the determination of impurities in the uranium (Fe, Si, Al, Zr), to the measurement of the components of uranium-base alloys (Mo, Li), and to the determination of uranium in wastes. The average of the results obtained for 10 determinations by the automated method compared favorably with the results obtained by the manual method. (M.C.G.)

58509 ANALYTICAL METHODS: CETAMA 1970. METHODS FROM 251 TO 300. Paris; Presses Universitaires de France (1971). (In French).

With certain exceptions, the 49 analytical methods appearing in this volume are not new methods; their principles have already been described and their reliability established. The following products were analyzed: Si, Al, Ti and Mg oxides (activation analysis); B or C (isotopic analysis by mass spectrometry); water (determination of Th by colorimetry); sea water (measurement of the β radioactivity index and radiometric determination of ^{90}Sr); liquid wastes and effluents (volumetric determination of Th and radiometric determination of ^{90}Y and ^{91}Y); Fe (determination of 24 impurities by activation analysis); gas mixtures and natural gas; graphite (determination of rare earth elements by activation analysis); Mg (determination of nitrogen, chlorine, Mn or Fe by colorimetry; spectrographic determination of mineral impurities); biological media (determination of Br in liquids and Cu in plants using activation analysis); Pu (preparation and titration of a standard Ce (IV) solution; preparation of ion exchange resins for Pu analysis; determination of Cr, Cu, F, Mo, Si, W, impurities or U); Pu fluorides; Pu oxides (determination of Pu, Cu, Fe, F, mineral impurities, Pu, Th); Pu solutions; irradiated fuels and fission products (determination of ^{144}Ce, ^{106}Ru and U(IV)); U and U alloys, fluorides and oxides, uraniferous concentrates and solutions (determination of Al, Co, impurities, Ni, rare earths, Mo, V, W and U); Zr alloys (determination of Cu). (France)

58510 DETERMINATION OF SAMARIUM AND EUROPIUM IN NEODYMIUM OXIDE BY A LUMINESCENCE METHOD. Poluektov, N. S.; Efryushina, N. P.; Smirdova, N. I. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh.; 38: No. 4, 365-9(Apr 1972). (In Russian).

The luminescence spectrum of Sm and Eu was studied in the crystallophosphore $Nd_xY_{1-x}VO_4$, in which x = 0.0025 to 0.01 for Sm, and 0.0025 to 0.02 for Eu. Using this luminescence technique, a method was developed for determining Sa and Eu in Nd_2O_3; its sensitivity = (6 to 8) $\times 10^{-4}$. The intensity of the luminescence was proportional to the rare earth content up to 500 μg in 100 mg of the crystallophosphore. (tr-auth)

58511 FLUORIMETRIC DETERMINATION OF NIOBIUM WITH QUERCETIN AND HYDROGEN PEROXIDE. Pilipenko, A. T.; Zhebentyaev, A. I.; Volkova, A. I. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh.; 38: No. 4, 363-5 (Apr 1972). (In Russian).

Optimum conditions were established for the formation of a complex compound Nb$-H_2O_2-$quercetin, and its molar extinction coefficient and quantum yield of luminescence were measured. The effect of organic solvents (methanol, ethanol, and acetone) on the intensity of fluorescence was studied. The possibilities of the technique as a determinative method for Nb are discussed, and procedures for enhancing its sensitivity are given. (tr-auth)

58512 EXTRACTION OF URANIUM(VI) BY ACRIDINE ORANGE NO. Tarayan, V. M.; Ovsepyan, E. N.; Petrosyan, A. A. (Erevan State Univ.). Arm. Khim. Zh.; 24: No. 11, 966-70(1971). (In Russian).

The U(VI) benzoate complex with Acridine Orange NO was extractable with benzene, and its apparent molar light absorption coefficient was 5.4×10^4. The extraction discrimination of the following ions was measured: Th, Zr, Ti, Ce, Pb, Mn, Cu, and Co. The benzoate anion of U(VI) and the dye cation were present in the complex in a 1:1 ratio. Based on these data, a method was developed for a quantitative determination of U(VI) in microgram amounts. (K.S.W.)

58513 DETERMINATION OF RARE EARTH ELEMENTS OF THE YTTRIUM SUBGROUP BY EXTRACTION—DIFFERENTIAL SPECTROPHOTOMETRY. Akhmedin, M. K.; Ayubova, A. M.; Imamverdieva, F. B. Dokl. Akad. Nauk Azerb. SSR; 28: No. 2, 32-5(1972). (In Russian).

The complex formed between the yttrium subgroup rare earths, xylenol orange, and diphenylguanidine can be used to determine these elements using extraction–differential spectroscopy. The error amounts to 0.16%. The method can be used to analyze minerals and alloys. (auth)

58514 COLOR REACTIONS OF RARE EARTHS WITH A NEW REAGENT: 2-CARBOXYBENZENE-(1-AZO-2)-1,8-DIHYDROXYNAPHTHALENE-3,6-DISULFOACID-(7-AZO-1)-4-NITROBENZENE. Savvin, S. B.; Petrova, T. V.; Romanov, P. N. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 6, 1257-62(Jun 1972). (In Russian).

Color reactions were produced by individual rare earths and the reagent CDDN, which were distinguished by sensitivity. The greatest difference was observed for the cerium and yttrium subgroups. There exists a possibility for determining the elements of the Ce subgroup in the presence of a 40-fold amount of elements of the yttrium subgroup. The selectivity of the reaction between La and CDDN in relation to other cations and anions was investigated. (K.S.W.)

58515 INTERACTION OF ANTIPYRINE S AND ITS ANALOGS WITH RARE EARTHS ELEMENTS. Savvin, S. B.; Sokolovskaya, L. A.; Rozovskii, Yu. G. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 27: No. 7, 1263-9 (Jul 1972). (In Russian).

The reaction for the formation of the complex of lanthanum with Antipyrine S was studied. The step change in the composition of the complexes formed is shown. The complex of the composition of MeR_4 is of the most importance analytically. Antipyrine S is recommended for the photometric determination of lanthanum. The reaction is highly sensitive ($\epsilon = 100.10^3$), and contrast is ($\Delta\lambda = \lambda_{max,\ MeR} - \lambda_{max,\ R} = 140$ nm). The conditions for the determination: 1 to 25 μg La in 25 ml, 0.5 ml of 1.10^{-3} M solution of the reagent, pH = 2.5. It was found that Antipyrine S gives several somewhat different reactions with separate rare earth elements. The difference increases with introducing complexone III into the solution. It permits the use of Antipyrine S for determining certain elements of the Ce group in the presence of those of the Y group. (auth)

58516 PHOTOCHEMICAL REACTIONS IN ANALYTICAL CHEMISTRY. COMMUNICATION 12. PHOTOCHEMICAL OXIDATION AND REDUCTION OF DIFFERENT VALENCE STATES OF NEPTUNIUM IN HYDROCHLORIC ACID SOLUTIONS. Nemodruk, A. A.; Bezrogova, E. V.; Ivanova, S. A.; Novikov, Yu. P. Zh. Anal. Khim.; 27: No. 7, 1270-5(Jul 1972). (In Russian).

The behavior of different valence states of neptunium in hydrochloric acid solutions under irradiation by the uv light of a mercury vapor lamp PRK-7 was studied according to effects of the duration of the irradiation, HCl concentration, neptunium concentration, the presence of chlorides of alkali metals and the additives of different electron-donor organic substances (ethanol, formic and acetic acids) as well as hydrogen peroxide. The irradiation of hydrochloric acid solutions of neptunium(IV) and neptunium(V) leads to their quantitative oxidation to neptunium (VI). The rate of the oxidation increases with increasing HCl concentration. Irradiation in the presence of hydrogen peroxide results in the formation of neptunium(V) from all valence states of neptunium. Neptunium(V) and neptunium(VI) are completely reduced to neptunium(IV) during the 20-min irradiation of neptunium solutions in the presence of 2% ethanol. The photochemical reduction of neptunium(V) and neptunium(VI) to neptunium(IV) can be used for its photometric determination by Arsenazo III. (auth)

58517 ELECTROCHEMICAL BEHAVIOR OF A GOLD ELECTRODE DURING POTENTIOMETRIC TITRATION OF ZIRCONIUM AND TITANIUM BY A CUPFERRON SOLUTION. Ivanova, Z. I.; Rivina, V. Y a.; Kimstach, V. A. (Rostov State Univ., USSR). Zh. Anal. Khim.; 27: No. 7, 1289-92(Jul 1972).

A gold electrode can be used as an indicator during potentiometric titration of zirconium and titanium by cupferron. The oxidation of cupferron on the electrode is the potential determining process in this titration. During the titration under current cupferron can be oxidized or reduced depending on the direction and the magnitude of the current. (auth)

58518 PYRAZOLONE DERIVATIVES IN ANALYTICAL CHEMISTRY OF MOLYBDENUM. COMMUNICATION 1. GRAVIMETRIC DETERMINATION OF MOLYBDENUM BY MEANS OF PYRAMIDONE. Eremin, Yu. G.; Kolpikova, E. F.; Guseva, K. S. (Kalinin Polytechnic Inst., Moscow). Zh. Anal. Khim.; 27: No. 7, 1293-6(Jul 1972). (In Russian).

A ternary compound of pentathiocyanatooxymolybdate with pyramidone, $MoO(CNS)_5 \cdot 2Pyr$, was synthesized. Optimum conditions were found for quantitative precipitation of molybdenum as the compound mentioned using 1 to 9N HCl or H_2SO_4, 1 to 2% CNS solution, and not less than a threefold excess of pyramidone. A gravimetric method is suggested for determining molybdenum in electrocarbon goods. (auth)

58519 PRECIPITATION OF COMPLEX MOLYBDENYL THIOCYANATE BY MEANS OF TETRAETHYLAMMONIUM. Eremin, Yu. G.; Kolpikova, E. F.; Dorfman, A. E. (Kalinin Polytechnic Inst., Moscow). Zh. Anal. Khim.; 27: No. 7, 1297-1300(Jul 1972). (In Russian).

A compound of molybdenyl pentathiocyanate with tetraethylammonium, $MoO(CNS)_5[(C_2H_5)_4N]_2$, was synthesized. Optimum conditions were found for the quantitative precipitation of molybdenum(V) as the compound mentioned using 1 to 7N HCl or H_2SO_4, 5% SCN^- solution, 6-fold excess of the precipitant, the concentration of molybdenum of above 0.5 μg/ml. A gravimetric method was worked out for determining molvbdenum(V) at its concentration of 20 μg/ml with the ignition of the precipitate to MoO_3. Alkali and alkaline earth metals, Al, Ni, Co, Ti, Fe(III), Mn, MoO_4^-, VO_3^-, Zn, Zr, and Cd do not interfere. The method was tested on some samples of electrocarbon goods composed of carbon+MoS_2. (auth)

58520 DETERMINATION OF RUTHENIUM BY THE KINETIC METHOD BASED ON THE OXIDATION REACTION OF p-ANISIDINE WITH MANGANESE SULFATE. Goncharik, V. P.; Yatsimirskii, K. B.; Tikhonova, L. P. (Inst. of Physical Chemistry Kiev). Zh. Anal. Khim.; 27: No. 7, 1348-51(Jul 1072). (In Russian).

A new kinetic method based on the use of the catalytic reaction of the oxidation of p-anisidine with manganese(III) sulfate was worked out for determining ruthenium. The sensitivity of the method is 6×10^{-9} g/ml Ru in 10 ml of the solution, the relative error does not exceed 14%. The method can be used for determining ruthenium in mixtures of platinum group elements. (auth)

58521 ATOMIC-ABSORPTION DETERMINATION OF MAGNESIUM IN COMPOUNDS OF RARE EARTHS ELEMENTS. Poluektov, N. S.; Zelyukova, Yu. V. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 27: No. 7, 1352-6(Jul 1972). (In Russian).

It was found that the addition of salts of rare earth elements to an aqueous solution of magnesium increases the absorption of light by magnesium atoms in the gases of the low-temperature flame of a mixture of propane–butane–air. The effect is conditioned by the processes proceeding in the flame during the evaporation of the aerosol particles of the solution. The ratio of Mg : REE in the compounds formed (Mg evaporates from them easier than MgO) is 3 : 2. The atomic absorption method was used for determining magnesium in compounds of rare earths with the sensitivity of 2×10^{-5}%. (auth)

58522 ADAPTER FOR A FLUOROMETER FO-1 FOR EXCITATION IN SHORT WAVE RANGE. FLUOROMETRIC DETERMINATION OF CERIUM. Shcherbov, D. P.; Inyutina, O. D.; Plotnikova, R. N.; Kos'yanenko, V. I. (Inst. of Mineral and Raw Materials, Alam-Ata, USSR). Zh. Anal. Khim.; 27: No. 7, 1407-10(Jul 1972). (In Russian).

The adaptor with a source PPBL-3 for a fluorometer FO-1 permits the determination of cerium by the uv fluorescence of Ce^{3+} ions within their content range of 0.1 to 180 μg in 15 ml of 0.5N H_2SO_4. (auth)

58523 SPECTRAL ANALYSIS OF HIGH-MINERAL NATURAL WATER FOR MICROELEMENTS WITHOUT THEIR PRECONCENTRATION. Khitrov, V. G.; Belousov, G. E. (Inst. of Geology of Ore Deposits, Petrography, Mineralogy, and Geochemistry, Moscow). Zh. Anal. Khim.; 27: No. 7, 1357-63(Jul 1972). (In Russian).

A very simple and sensitive method is suggested for the simultaneous determination of 10 microelements (including, B, Ba, Ge, Cd, Mo, Ag, Pb, Sr, Tl, and Zn, with a content of 10^{-3} to 10^{-6}%) in high-mineral natural water with the content of salts of 0.5 to 100 g/l and more. The method makes it possible to extend considerably geochemical studies of underground and ground natural water. The method can be carried out using conventional spectral instruments. (auth)

58524 CONDITIONS FOR USING AN ALUMINUM ELECTRODE IN POTENTIOMETRIC TITRATION BASED ON CORROSION DATA. Chekmareva, L. I.; Abilov, V. B.; Klimov, Yu. F.; Kolmogorova, T. A. (Khabarovsk Polytechnic Inst., USSR). Zh. Anal. Khim.; 27: No. 7, 1401-3(Jul 1972). (In Russian).

Conditions are given under which a metal oxide electrode can be used for potentiometric indication of the neutral point. Possibilities for the use of an aluminum electrode in reactions of neutralization, oxidation–reduction, precipitation and complex formation were experimentally confirmed. The possibility for using an aluminum electrode for analysis of a mixture of halides by titration with $AgNO_3$ in an aqueous alcohol solution is discussed. (auth)

58525 SPECTROPHOTOMETRIC DETERMINATION OF NEPTUNIUM BY ITS ABSORPTION IN HEPTAVALENT STATE. Shilov, V. P.; Krot, N. N.; Gel'man, A. D. (Inst. of Physical Chemistry, Moscow). Zh. Anal. Khim.; 27: No. 7, 1410-11 (Jul 1972). (In Russian).

A spectrophotometric method was developed for determining neptunium by absorption in its heptavalent state. The duration of a determination is 1h. (auth)

58526 DETERMINATION OF MICROAMOUNTS OF URANIUM IN ROCKS AND MINERALS. Malyasova, Z. V. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Zh. Anal. Khim.; 27: No. 7, 1414-16(Jul 1972). (In Russian).

A method was developed for the rapid luminescent determination of uranium in rocks and minerals with its content of between 1×10^{-4} and 1×10^{-6}%. Uranium is sorbed from the solution by charcoal at pH 4 to 6 in the presence of Complexone III. The error of the determination does not exceed 15%. (auth)

58527 STRONTIUM DISTRIBUTIONS IN SEA WATER PROFILES FROM THE GEOSECS I (PACIFIC) AND GEOSECS II (ATLANTIC) TEST STATIONS. Brass, G. W.; Turekian, K. K. (Yale Univ., New Haven). Earth Planet. Sci. Lett.; 16: No. 1, 117-21(Sep 1972).

Strontium was determined in Geosecs I and II test station profiles by mass spectrometric isotope dilution (MSID) analysis and atomic absorption spectrophotometry. The Geosecs I profile shows a range in μg Sr/g salinity from 218 to 223 by MSID and Long Island Sound water yields a value of 214. A maximum is indicated in Geosecs I at a depth of about 500 meters as outlined by the atomic absorption data. Comparison of atomic absorption data for the Atlantic and Pacific test stations through standardization by MSID indicates that the deep Atlantic is about 1.5% lower in Sr/salinity than the deep Pacific. As the differences are about as large as the coefficient of variation, future results will be made exclusively by MSID with a much smaller error. (auth)

58528 BARIUM AND STRONTIUM CONCENTRATIONS IN PACIFIC AND MEDITERRANEAN SEA WATER PROFILES BY DIRECT ISOTOPE DILUTION MASS SPECTROMETRY. Bernat, Michel; Church, Thomas; Allegre, Claude J. (Univ., Paris). Earth Planet. Sci. Lett.; 16: No. 1, 75-80(Sep 1972).

The determination of barium and strontium directly from seawater by isotope dilution mass spectrometry proves to be an efficient, precise, and virtual blank-free procedure. Results for an eastern Pacific profile confirm a regularly increasing barium concentration from 5 to 23 μg/kg at 2500 m, but strontium concentrations appear to be nearly homogeneous below 50 m at 7.6 ± 0.1 μg/kg with a single low value for the surface water. Results for a western Mediterranean profile show uniform concentrations for both barium and strontium, similar to the Atlantic. There appears to be a nearly conservative strontium-to-salinity ratio of 0.218 ± 0.002 for seawaters below mixed surface zones. The barium salinity ratio for the Mediterranean and Atlantic is $(0.30 \pm 0.01) \times 10^3$, but the integrated Pacific profile shows a ratio almost twice as great. (auth)

58529 BARIUM INTERCALIBRATION AT GEOSECS I AND III. Bender, Michael (Lamont-Doherty Geological Observatory, Palisades, N. Y.); Snead, Thomas; Chan, L. H.; Bacon, Michael P.; Edmond, John M. Earth Planet. Sci. Lett.; 16: No. 1, 81-3 (Sep 1972).

Previously reported results on barium concentrations in seawater at Geosecs I and III determined by Bacon and Edmond using mass spectrometry—isotope dilution (MSID), by Chan using MSID, and by Bender and Snead using stable isotope dilution neutron activation (SIDNA) agree to ±2%. Further improvement depends on suitable standardization procedures. (auth)

58530 COLLABORATIVE STUDY OF THE DETERMINATION OF MOLYBDENUM IN FERTILIZERS. Koirtyohann, S. R. (Univ. of Missouri, Columbia). J. Ass. Offic. Anal. Chem.; 55: No. 5, 989-90(Sep 1972).

An atomic absorption method for the determination of molybdenum in fertilizers was tested collaboratively. The results indicate that additional work is needed to improve precision at low molybdenum levels and to test for a possible positive bias in the method. (auth)

58531 DETERMINATION OF MOLYBDENUM BY ATOMIC-ABSORPTION SPECTROPHOTOMETRY. Purushottam, A.; Naidu, P. P.; Lal, S. S. (Geological Survey of India, Faridabad). Talanta; 19: No. 10, 1193-8(Oct 1972).

A new procedure is described for precise estimation of molybdenum by atomic absorption spectrophotometry using an air-acetylene flame. Phosphoric acid was found to be effective in suppressing interference by Fe(III), Al, Sb(III), Ca, Mg, Pb, and Mn(II). (auth)

58532 KINETIC DETERMINATION OF ULTRATRACE AMOUNTS OF IODIDE IN PERCHLORIC–HYDROCHLORIC ACID MEDIUM. Fukasawa, Tsutomu; Iwatsuki, Masaaki; Uesugi, Keiko (Yamanashi Univ., Takeda, Japan). Jap. Anal.; 21: No. 9, 1169-73(Sep 1972). (In Japanese).

A kinetic analytical method for 0.01 to 0.1 μg of iodide in a perchloric and hydrochloric acid medium was developed. The method is based on the catalytic effect of iodides on the oxidation of arsenious ions with ceric ions. It is also applicable to the determination of ultratrace amounts of iodide in combination with an anion-exchange technique. A neutral sample solution containing iodide is taken into a test tube. Perchloric acid and sodium chloride solution are added and mixed. In the case of the combined method with the anion-exchange separation, hydrochloric acid is added to sodium perchlorate effluent containing iodide in order to make the acidity of the solution the same as that described. The resulting solution is taken in the test tube. Ceric sulfate solution and sodium arsenite solution are added. After keeping at 30 ± 0.1°C for 20 min, ferrous sulfate solution is added in order to reduce ceric ions not yet reacted, and to arrest the reaction of ceric–arsenious system. Then potassium thiocyanate solution is added and after standing for 50 min, the absorbance of the resulting ferric–thiocyanate solution is measured at 455 nm against water. In the case of the combined method with the anion-exchange, the same procedure is also carried out at 5 min of the reaction time using another sample solution. If the absorbance at 20 and 5 min of the reaction time is denoted as A_{20} and A_5, respectively, iodide is determined from the calibration curve of the log A_{20} and log (A_5/A_{20}) vs. iodide concentration. The effects of the experimental conditions and coexisting ions are described. (auth)

58533 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM(VI) BY EXTRACTION OF URANIUM(VI)–ARSENAZO III COMPLEX WITH QUATERNARY AMMONIUM CHLORIDE. Fukamachi, Kazumi (Fukuoka Prefectural Inst. of Public Health); Kohara, Hitoshi; Ishibashi, Nobuhiko. Jap. Anal.; 21: No. 9, 1165-9(Sep 1972). (In Japanese).

The extraction of uranium(VI)-Arsenazo III complex with a high-molecular-weight ammonium salt was investigated in order to increase the sensitivity and selectivity of the spectrophotometric determination of uranium(VI) with Arsenazo III. Arsenazo III and its uranium(VI) complex were extracted into various organic solvents, i.e. toluene, chloroform, 1,2-dichloroethane, butanol etc., in the presence of high-molecular-weight ammonium chloride. A sample containing 0 to 30 μg of uranium(VI) was taken in 50 ml extractive tube, EDTA was added, and the pH of the solution was adjusted to 0.8 to 1.2. Arsenazo III solution was added, 5% dodecyloctylmethylbenzylammonium chloride—chloroform solution was added, and the solution was shaken for about ten minutes. Beer's law was obeyed at least up to 1.2×10^{-5} M uranium(VI) in the chloroform solution. The presence of manganese(II), nickel(II), copper(II), zinc(II), cadmium (II), aluminum(III), chromium(III), iron(III), zirconium(IV), vanadium(V), and tungsten(VI) caused no disturbance of the determination of uranium(VI), but thorium(IV) was extracted just as the uranium(VI) complex and interfered. The sensitivity of this method was twice as much as that of the extraction method using diphenylguanidium chloride—butanol solution. (auth)

58534 PHOTOMETRIC DETERMINATION OF BISMUTH, COPPER, AND TELLURIUM WITH DIETHYLDITHIOCARBAMIC ACID. Kuroha, Toshiaki; Shibuya, Seiji (Furukawa Electric Co. Ltd., Tokyo). Jap. Anal.; 21: No. 9, 1197-1201(Sep 1972). (In Japanese).

Successive photometric determination of Bi, Cu, and Te is presented. These colored diethyldithiocarbamate complexes are extracted into an organic solvent from the alkaline solutions containing EDTA while other colored metal chelates are not extracted. Bismuth, Cu, and Te are extracted into dilute nitric acid from the solution containing these diethyldithiocarbamates. Copper has a greater chelate formation constant with the carbamate than Te and Cd, and gives selectively a substitution reaction with Cd in the complex in the solvent, while Te does not. (M.C.G.)

58535 ANALYTICAL CURVES IN ATOMIC FLUORESCENCE SPECTROMETRY. Svoboda, V.; Browner, R. F.; Winefordner, J. D. (Univ. of Florida, Gainesville). Appl. Spectrosc.; 26: No. 5, 505-22(1972).

The shapes of theoretical growth curves in atomic fluorescence spectrometry were calculated for several possible atomizer cell geometries, for several geometries of illumination measurement, for both line and continuum sources of excitation, and for several a parameter values. Factors relating the shapes of theoretical growth curves to experimental growth curves (analytical curves) are discussed. Theoretical atomic fluorescence growth curves for hypothetical atoms having a parameters of 5, 2, 1, 0.4, and 0.1; for three different limiting cases characterizing the geometry of illumination measurement; and for both line and continuum sources are given. (33 references) (auth)

58536 ATOMIC ABSORPTION AND ATOMIC FLUORESCENCE SPECTROMETRY IN BIOCHEMISTRY AND MEDICINE. V.

DETERMINATION OF MANGANESE AND STRONTIUM IN BLOOD SERUM WITH THE HELP OF THE PERKIN-ELMER HGS-70 GRAPHITE FURNACE. Bek, Frantisek; Janouskova, Jana; Moldan, Bedrich (Ustredni Ustav Geologicky, Prague). Chem. Listy; 66: No. 8, 867-75(Aug 1972). (In Czech).

A non-flame atomizer for atomic absorption spectrometry, the graphite furnace Perkin-Elmer HGA-70, and its application for direct determination of manganese and strontium in human blood serum are described. This technique allows both elements to be determined at normal physiological levels with relative standard deviations of ±5.3 and ±4.8% for Mn and Sr, respectively. (auth)

58537 DETERMINATION OF NIOBIUM IN STEEL BY ATOMIC-ABSORPTION SPECTROPHOTOMETRY. Martin, M. J. (Gas Council Research Station, London). Analyst; 97: No. 1154, 394-9(May 1972).

The determination of niobium by atomic-absorption spectrophotometry is complicated by many matrix effects. For the determination of niobium in steels, the interference effects were avoided by separating the niobium and re-dissolving it in ammonium sulphate-sulphuric acid and adding tartaric acid to stabilise the solution. Potassium sulphate was added as an ionisation suppressant to all the solutions containing niobium. An aqueous solution of niobium must have a concentration in the range 100 to 1000 μg ml^{-1} to give satisfactory absorption results. (auth)

58538 APPLICATION OF EXTRACTION METHODS IN SPECTROCHEMICAL ANALYSIS. Kantor, Tibor; Polos, Laszlo; Bezur, Laszlo. Magy. Kem. Lapja; 27: No. 6, 313-15(1972). (In Hungarian).

A report is presented on the application of chemical extraction methods in the field of flame and arc-spark spectrometry. The bibliography given involves the references of the last four years in connection with the subject in question. Extraction data are given for several elements, including Mo, U, Hf, Zr, Nb, and Sr. (auth)

58539 DETERMINATION OF MOLYBDENUM IN PLANTS. REVIEW OF METHODS AND DEVELOPMENT OF A COLORIMETRIC METHOD WITH THIOCYANATE. Duval, L.; Le Goff, Paulette. Ann. Agron.; 22: No. 1, 127-47(1971). (In French).

Methods for the determination of molybdenum are reviewed (44 references), and the following procedure is proposed. Ignite the ground plant material (5 g) in a muffle-furnace at 600° to 700° for 3 hr., cool the ash, add 6M-HCl (10 ml), and evaporate to dryness on a sand bath. Extract the residue with further portions of 6M-HCl, filter, and dilute the combined extracts to 50 ml with 6M-HCl. To this solution add 10 ml of Cu solution (dissolve 275 mg of $CuSO_4 \cdot 5H_2O$ in 1 litre of 1.5M-HCl) and 5% ascorbic acid solution (20 ml), mix, and after 2 to 3 min., add butyl acetate (10 ml) and 0.2M-NH_4SCN (20 ml), and shake for 1 min. Separate the organic phase, wash it with a freshly prepared 5% $SnCl_2 \cdot 2H_2O$ solution in 2M-HCl (10 ml), and measure its extinction at 468 nm (3-cm cell). Recovery of Mo ranges from 96 to 102%. (Anal. Abstr.)

58540 EXAMINATION OF METHODS FOR DETERMINING ZIRCONIUM IN TITANIUM ALLOYS. Tenyakova, L. A.; Naplavkova, N. P. Tekhnol. Legkikh Splavov, Nauch.-Tekh. Byull. VILSa; No. 3, 61-4(1970). (In Russian).

With the aim of unifying such methods, three alloys were analyzed in six laboratories by three gravimetric methods (with phosphate, mandelic acid or benzenearsonic acid) and by a complexometric method with xylenol orange as indicator. After statistical processing of the results, the complexometric method was recommended for routine use, and the gravimetric phosphate method for control analyses. The mandelic acid method should only be used with a double precipitation, and the benzenearsonic acid method should be discarded, as it is inaccurate and imprecise. The permissible deviations between results for a duplicate analysis are 0.25% for alloys containing 12% of Zr and 0.08% for a Zr content of 2.5%. (Referativnyi Zh.)

Radiometric and Radiochemical Procedures

Refer also to abstracts 59231 and 60419.

58541 (LA-DC-72-1069) SENSITIVITY AND DETECTABILITY LIMITS FOR ELEMENTAL ANALYSIS BY PROTON-INDUCED X-RAY FLUORESCENCE WITH A 3 MV VAN DE GRAAFF. Umbarger, C. J.; Bearse, R. C.; Close, D. A.; Malanify, J. J. (Los Alamos Scientific Lab., N. Mex.). 1972. 13p. (CONF-720801-2). Dep. NTIS.

From 21st conference on applications of x-ray analysis; Denver, CO. (2 Aug 1972).

Protons from a 3-MV Van de Graaff were used to produce characteristic x-rays from 21 elements spanning the periodic table. Absolute K_α and L_α x-ray production cross sections were determined, allowing one to calculate sensitivities for any given sample, detector geometry, and proton beam parameters. Elemental detectability limits are discussed assuming various backings (e.g., mylar, kapton, etc.) and matrix materials. The large number of available small proton accelerators throughout the United States promises wide applicability of this technique to environmental and biomedical analysis. (auth)

58542 INEQUILIBRIUM OF THORIUM SERIES RADIONUCLIDES IN THE SEDIMENTS AROUND A RIVER MOUTH. Miyake, Hiroshi; Michijima, Masami (Kobe Univ., Japan). Radioisotopes (Tokyo)· 21: No. 2, 74-9(Feb 1972). (In Japanese).

The distribution of ^{228}Th and ^{228}Ra concentrations in sediments around a river mouth was studied. High resolution gamma spectrometry with a Ge(Li) detector made it possible to analyze the radionuclides in the sediment samples without chemical treatment. The activities of ^{228}Th and ^{228}Ra were determined from the activities of their daughters. Samples containing monazite sand of known activity were used as the standards in which the thorium series radionuclides were in secular equilibrium. The radionuclides were mostly accumulated in a narrow band stretching along the stream from the river. The activity ratios of ^{228}Th to ^{228}Ra were large at the river mouth and at the places in the band. The activity ratios of ^{228}Th to ^{232}Th were also measured with alpha spectrometry using a double grid ionization chamber. These studies made clear the situation of the fractionation effect around a river mouth due to the difference of chemical properties between thorium and radium in the seawater. (auth)

58543 SHIPBOARD ANALYSIS OF ^{90}Sr IN SEAWATER ON GEOSECS II. Major, William J.; Lee, Kim D.; Wessman, Robert A. (TRAPELO/WEST, Richmond, Calif.). Earth Planet. Sci. Lett.; 16: No. 1, 138-40(Sep 1972).

Strontium-90 in seawater samples was analyzed aboard the USS Knorr by direct extraction of the ^{90}Y daughter. The extraction was made in two 17-gallon heavy-walled glass bottles. Yttrium carrier was added and the ^{90}Y was extracted with HDEHP in toluene, back-extracted with HCl, and purified with a second HDEHP extraction. The Y was mounted as the oxalate and counted in a methane end window system. Check analyses were performed in a shore-based laboratory equipped with low background beta counters. The results of the sea and shore analyses were consistent within the limits of error. The test demonstrates that ^{90}Sr analyses can be performed satisfactorily at sea, and that a better equipped laboratory and counting facility would improve the performance considerably. (auth)

58544 ANALYSIS OF Pu-Am SPECTRA IN A Xe PROPORTIONAL COUNTER. EFFECT OF CHARACTERISTIC X-RAYS. Yaniv, S. S.; Brodsky, A.; Sashin, D. (Univ. of Pittsburgh). Health Phys.; 23: No. 5, 705-14(Nov 1972).

In developing a method for the evaluation of in vivo plutonium and americium in the absence of a priori knowledge of the Pu-to-Am ratio, xenon-filled proportional counters were employed. Analysis of Pu-Am spectra indicated that many counts observed in the plutonium and americium L X-ray region were actually due to absorption by the detector of higher-energy photons followed by the escape of xenon characteristic X-rays. The higher-energy photons originated mainly in americium (Compton-scattered 59.6 keV gammas), and to a smaller degree in plutonium. Quantitative assessment of in vivo Pu-Am thus requires correction of the count-rate in the L X-ray region for these contributions from higher-energy photons. This correction is particularly important in cases where the contaminant is located deep within the body, since the L X-rays are attenuated faster than the higher-energy photons. The relative importance of this correction thus depends upon the Pu-to-Am ratio, the thickness and type of absorber, and the particular detector used. In practice, an approximate correction factor for each case was obtained from spectra in the 35 to 55 keV region obtained simultaneously with the corresponding spectra in the L X-ray region. The contribution of these high-energy photons to count rates observed in the L X-ray region severely limits the practical usefulness of xenon-filled proportional counters for quantitative evaluation of plutonium and americium body burdens. (auth)

58545 X-RAY FLUORESCENCE SPECTROMETRIC DETERMINATION OF RARE EARTH ELEMENTS IN ALLOYS. Matano, Nobuhisa (National Research Inst. for Metals, Tokyo). Jap. Anal.; 21: No. 9, 1187-91(Sep 1972). (In Japanese).

The determination of cerium group rare earth elements in alloys by x-ray fluorescence spectrometry is described. The spectra obtained from pure rare earth elements are shown. From a study of the absorption edge of cerium group rare earth elements, it is expected that Sm and Eu will exit the fluorescent radiation from La; La will absorb the radiation from Sm and Eu; and La, Ce, Pr and Nd will not effect each other. The absorption and/or enhancement effect was found in the La-Sm system. In order to overcome the difficulty described above, the addition of strontium carbonate to the sample was tried. It will tend to reduce the absorption and/or enhancement effects on the elements to be analyzed by providing a constant absorbing matrix. The addition of strontium carbonate was very effective. After the separation of the rare earth elements from the base metals by the conventional wet-chemical method, the compound obtained was converted to the oxide. The mixture of one part of the oxide, 20 parts of lithium tetraborate, and 6 parts of strontium carbonate was fused in a graphite crucible at 1050°C for 20 minutes. The cooled bead was ground and pressed at 60 t into a pellet 33 mm in diameter. The standard samples were prepared from pure chemicals. X-ray fluorescence measurements of these samples yielded a linear working curve. The curve shows a linear relationship between the intensity ratio and the weight ratio of the oxide of rare earth elements over the whole range investigated. The standard error of estimate from regression was 0.75%. (auth)

58546 ANALYTICAL APPLICATIONS OF X-RAY EXCITED OPTICAL FLUORESCENCE SPECTRA. II. DETERMINATION OF RARE EARTH ELEMENTS IN STAINLESS STEEL. **Kato, Kaneharu; Takashima, Kyoichiro; Nakajima, Tokunosuke (Japan Atomic Energy Research Inst., Tokai). Jap. Anal.; 21: No. 9, 1154-60(Sep 1972). (In Japanese).**

A quantitative technique for analysis of small amounts of samarium, europium, gadolinium, and dysprosium in stainless steel is described. The rare earths were coprecipitated with thorium carrier from an acid solution as $NH_4F \cdot ThF_4$. In order to avoid the coprecipitation of chromium(III) fluoride, major amounts of chromium were first vaporized off as CrO_2Cl_2. The separated white precipitate of $NH_4F \cdot ThF_4$ was dissolved with H_3BO_3 and hot concentrated HNO_3. Then, thorium was twice precipitated as $Th(OH)_4$ with NaOH and NH_4OH. The filtered precipitate was dissolved with hot HNO_3. The solution was diluted to about 50 ml with water. The acidity of the solution was made pH = 1.1. The solution was heated to near dryness. Then, concentrated HNO_3 and 70% $HClO_4$ were added and gently evaporated to dryness on the hot plate. The residue was dissolved with concentrated HNO_3 and the resulting solution was diluted to exactly 100 ml with water. The optimum dilution factor was determined and of samarium, europium, gadolinium, and dysprosium were determined by standard addition method. Thorium and terbium were added to the pipetted sample solution, and water was added to dilute the volume to about 100 ml. Terbium was used as a monitor of the recovery process and as an internal standard. The solution was heated until it almost boiled and then a hot oxalic acid solution was added and boiled. The resulting precipitate of thorium oxalate was filtered. The precipitate with the filter paper was transferred to a porcelain crucible and ashed. Then it was heated at 1000°C for 1 hr and converted to the powders containing thorium oxide. The thorium oxide was excited by x-ray irradiation and the resulting fluorescence spectra used for determination of samarium, europium, gadolinium, and dysprosium. Existence of large amounts of other rare earth elements such as lanthanum, cerium, praseodymium, etc., seriously affected the fluorescence intensities of samarium, europium, gadolinium, and dysprosium. Appropriate dilution of the sample with pure thorium reduced the effect and thus quantitative determination could be made. The limits of detection were 20 ppB for gadolinium, 0.1 ppM for europium, 0.3 ppM for samarium, and 0.5 ppM for dysprosium. (auth)

58547 CLASSIFICATION OF ARCHAEOLOGICAL ARTIFACTS BY APPLYING PATTERN RECOGNITION TO TRACE ELEMENT DATA. **Kowalski, B. R. (Shell Development Co., Emeryville, Calif.); Schatzki, T. F.; Stross, F. H. Anal. Chem.; 44: No. 13, 2176-80(Nov 1972).**

The application of four nonparametric pattern recognition methods to the identification of (obsidian) artifacts using the x-ray fluorescence data for 10 trace elements is discussed. The classification algorithms are illustrated, and their relative usefulness is discussed. (auth)

58548 DETERMINATION OF RARE-EARTH, YTTRIUM, AND SCANDIUM ABUNDANCES IN ROCKS AND MINERALS BY AN ION EXCHANGE–X-RAY FLUORESCENCE PROCEDURE. **Eby, G. Nelson (Lowell State Coll., Mass.). Anal. Chem.; 44: No. 13, 2137-43(Nov 1972).**

The method involves dissolution of a geologic sample in an appropriate acid medium, separation of the rare earths, yttrium, scandium, and barium by a strong acid cation exchange procedure, removal of the barium as a barium sulfate precipitate, and collection of the remaining ions on ion exchange paper. The concentrations of the individual elements are determined by x-ray fluorescence. Single element standards are used to establish corrections for the various interferences in the complex rare earth x-ray spectrum. The method yields a precision of ±10 to ±20% for all elements down to concentrations of 1 to 2 μg/gram. Detection limits normally range from 0.5 to several μg/gram. Comparison with literature values for the U.S.G.S. standard rocks indicates relatively good agreement (10 to 30%) at the ppM level. (auth)

58549 ERRORS IN DETERMINATION AND THE CONDITIONS OF MEASUREMENT IN THE ANALYSIS OF TWO-COMPONENT MIXTURES OF ISOTOPES. **Navalikhin, L. V.; Sattarov, M. G. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 73-5(1972). (In Russian).**

Treatment of analytical data for mixtures of two or more radioisotopes may be complex, particularly when they release γ quanta or β particles with identical energies, and the half-lives are practically the only distinguishing variable. Correct choice of the optimal conditions of measurement renders the solution to these problems simpler and minimizes the error. The method proposed depends on activity determinations at two fixed moments in time, and solves two linear equations with two unknowns. (K.S.W.)

58550 INVESTIGATIONS OF DETERMINATION OF LEAD IN AIR BY MEANS OF IONIZING RADIATION METHOD. **Smal, Zbigniew. Pr. Cent. Inst. Ochrony Pracy; 21: No. 70, 185-91 (1971). (In Polish).**

Investigations of the determination of lead in air by means of ionizing radiation are described. The relationship between the intensity of the radiation passing through a nitric acid solution where lead was accumulated and the concentration of lead in solution was examined. The effect of silicon and zinc impurities was investigated. Beta ($^{90}Sr + ^{90}Y$) and gamma ($^{170}Tm + ^{153}Gd$) radiation sources were used. On the basis of investigations described the usefulness of those sources for analysis of lead under various conditions was determined. (auth)

58551 RADIOACTIVE POLLUTION IN NATURAL WATER. **Marques, Branca Edmee; Grade, Maria Regina Sales. Rev. Port. Quim. (Lisbon); 12: No. 3, 140-7(1970). (In Portuguese).**

Procedures for concentrating the radioactive isotopes (^{137}Cs and ^{90}Sr) are described. The water samples are preferably stored in polyethylene vessels at pH 1, and after adding carriers (Cs, Sr, Fe(III), Ni) and raising the pH to 8 with aqueous NH_3 the Ni is precipitated with $K_4FE(CN)_6$, saturated ammonium carbonate solution is added and the mixture is kept at 60° for 24 hr. The complex precipitate containing the Cs, Ni, Fe and K is separated by centrifuging and dissolved in H_2SO_4. An aqueous solution of the sulfates thus obtained is treated with aqueous NH_3 and NH_4Cl to precipitate the insoluble hydroxides and the solution is heated to fumes with $HClO_4$. Extraction of the solution with ethyl acetate–butanol (1 : 1) removes the soluble perchlorates, leaving a residue of $KClO_4$ and $CsClO_4$. This is dissolved in 3N-HNO_3 and Cs is separated from K by precipitation with molybdosilicic acid. The solution remaining after the precipitation with $K_4Fe(CN)_6$ contains the Ca and Sr, and the Sr is separated by the standard method with fuming HNO_3. The radioactivity of the Cs and Sr concentrates is then measured. (Anal. Abstr.)

58552 COMPARISON OF METHODS FOR THE PREPARATION OF ^{14}C-LABELLED PLANT TISSUES FOR LIQUID SCINTILLATION COUNTING. **Fuchs, A.; de Vries, F. W. (Landbouwhogeschool, Wageningen, Netherlands). Int. J. Appl. Radiat. Isotop.; 23: No. 8, 361-9(Aug 1972).**

Four methods for the preparation of ^{14}C-labelled plant tissues for liquid scintillation counting were compared for accuracy and precision. The wet oxidation method of Mahin and Lofberg (Anal. Biochem 16: 500(1966)), although easy and rapid, proved to be unsuitable for obtaining a reliable estimate of ^{14}C present in lyophilized plant material, showing nonquantitative recovery and poor reproducibility. Solubilization in hyamine hydroxide provided accurate and reproducible results, if experimental conditions were strictly adhered to; however, especially when larger samples were employed, severe and variable color quenching resulted in very low counting efficiency, which necessitated construction of quench correction curves specific for each source of plant material. Van Slyke wet combustion (J. Biol. Chem. 191 : 299(1951)), on the other hand, always resulted in reproducible and reliable data, irrespective of the carbon compound administered and the nature of the plant material. With samples of up to about 10 mg Schoniger dry combustion in the Micro-Mat BF 5010 oxidation system even outrivaled Van Slyke wet combustion, because of speed and ease of manipulation. The latter methods are, therefore, evidently superior to the wet oxidation method of Mahin and Lofberg and solubilization in hyamine hydroxide. (auth)

58553 ^{227}Ac DETERMINATIONS IN THE AIR AND ON SURFACES OF THE FLOOR AND EQUIPMENT. **Vorob'ev, A. M. Gig. Sanit.; No. 8, 84-6(Aug 1972). (In Russian).**

Techniques are described for obtaining air and surface contamination samples for ^{227}Ac assays. Air (10 to 20 m^3) was drawn through a fabric filter, which was ignited in a muffle furnace at 500 to 600°C. Cotton wadding was moistened with 1N HNO_3 and a single piece was rubbed over 150 cm^2 of surface area of floor or operating equipment. Extraction with a 50% solution of bis(2-ethylhexyl) phosphate in heptane, passage through an anion exchanger (for separating traces of Po), and an alpha count complete the procedure. The sensitivity of the method (for a background of 0.1 to 0.2 pulse/min) is 2×10^{-11} Ci of Ac, with probable error of ±15%. (K.S.W.)

Separation Procedures

Refer also to abstracts 58577 and 58660.

58554 CHEMISTRY OF RARE ELEMENTS. LXXIX. SEPARATION OF SCANDIUM FROM YTTRIUM, LANTHANUM, MANGANESE(II), ALUMINUM, GALLIUM, CERIUM, INDIUM, THALLIUM, IRON(II, III), THORIUM, YTTERBIUM, AND OTHER ELEMENTS CONTAINED IN MONAZITE SAND OF ASIATIC ORIGIN. Pesek, J.; Petru, F. (Technische Hochschule fuer Chemie, Prague). Collect. Czech. Chem. Commun.; 37: No. 8, 2528-33 (Aug 1972). (In German).

An ion-exchange chromatographic method for scandium separation from these elements using phosphoric acid solutions is described. (tr-auth)

58555 CHARACTERISTICS OF THE KINETICS OF THE SORPTION OF LANTHANUM AND NEODYMIUM CATIONS ON KU-6G CATION-EXCHANGE RESIN IN THE AMMONIUM-FORM. Legenchenko, I. A.; Strizhenyuk, S. L. (Inst. of General and Inorganic Chemistry, Odessa). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 2, 260-3(Feb 1972).

Translated from Zh. Fiz. Khim.; 46: No. 2, 454-9(Feb 1972).

The kinetics of the exchange of lanthanum and neodymium cations with NH_4^+ on KU-6G cation-exchange resin were investigated. A kinetic equation, derived on the hypothesis that external mass transfer is complicated by complex formation in the resin phase, is in satisfactory agreement with experimental data. (auth)

58556 CHROMATOGRAPHIC SEPARATION OF Re, Mo, V, AND W. Gaibakyan, D. S. (Erevan State Univ.). Arm. Khim. Zh.; 24: No. 10, 861-4(1971). (In Russian).

Separation of the ions Re(VII), Mo(VI), V(V), and W(VI) by thin-layer chromatography was studied using as the mobile phase a 1:1 mixture of acetone and 4 N H_2SO_4. Aqueous solutions of HNO_3 or H_2SO_4 could also be used. The existence of Mo in two states (negatively charged ion and a neutral compound) was established by thin-layer and paper chromatography and ionophoresis on paper. It was concluded that thin-layer chromatography could be utilized for studying the ionic state of a compound. (tr-auth)

58557 SEPARATION OF RARE EARTHS FROM MANGANESE. Davitashvili, E. G.; Dzhabishvili, N. A.; Landiya, M. V. (Inst. of Physical and Organic Chemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 67: No. 2, 329-30(Aug 1972). (In Russian).

A new method of separation of rare earths from manganese has been elaborated. It is based on the solubility of the various phosphates of these elements in acetic acid. (tr-auth)

58558 METAL-LIGAND VIBRATION FREQUENCIES AND THE PROBLEM OF THE STATISTICAL CALCULATION OF EQUILIBRIUM CONSTANTS FOR EXTRACTION REACTIONS. Rozen, A. M.; Denisov, D. A.; Nikolotova, Z. I. Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 3, 328-9(Mar 1972).

Translated from Zh. Fiz. Khim.; 46: No. 3, 566-8(Mar 1972).

The possibility of a statistical calculation of equilibrium constants for extraction reactions is examined. Data presented are for the infrared absorption spectra of uranyl nitrate and its complexes with tributyl phosphate and trioctylphosphine oxide. An approximate method is proposed for the calculation of equilibrium constants with increasing length of the hydrocarbon group of the extractant. (auth)

58559 EXTRACTION OF IODIDE COMPLEXES (A REVIEW). Prokoshev, A. A.; Chuchalin, L. K.; Iofa, B. Z.; Zolotov, Yu. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 27: No. 7, 1364-82(Jul 1972). (In Russian).

A review of the literature is given on the extraction of metal complexes (Cu, Ag, Au, Zn, Cd, Hg, In, Tl, Zr, Hf, Ge, Sn, Pb, As, Bi, Mo, Te, Po, and platinum metals) from iodide solutions. The data on the behavior of some elements in their extraction by several most important organic solvents are compared. The information on the extraction of hydriodic acid by different solvents depending on acid concentration is given. (auth)

58560 SILICON, RADIUM, THORIUM, AND LEAD IN SEAWATER: IN-SITU EXTRACTION BY SYNTHETIC FIBRE. Krishnaswami, S. (Tata Inst. of Fundamental Research, Bombay); Lal, D.; Somayajulu, B. L. K.; (and others). Earth Planet. Sci. Lett.; 16: No. 1, 84-90(Sep 1972).

Acrilan fibre loaded with ferric hydroxide concentrates Si and trace elements from tons of seawater. This synthetic fibre is cheap, relatively blank free and easily processed. ^{228}Ra/^{226}Ra activity ratios were measured by this technique in the Indian Ocean and the Mediterranean; the results are consistent with those made directly on seawater. Data are also reported on fibre enrichment factors relative to seawater for Si, Ra, Th, and Pb; these factors range from 200 to 10,000. (auth)

58561 ANALYTICAL GAS CHROMATOGRAPHY OF METAL CHELATES (A REVIEW). Sokolov, D. N. (Inst. of Chemical Physics, Chernogov, USSR). Zh. Anal. Khim.; 37: No. 5, 993-1001(May 1972). (In Russian).

The literature on the use of gas chromatography in analytical chemistry is reviewed. (41 references) (auth)

58562 RADIOCHROMATOGRAPHIC ANALYSIS AND ITS APPLICATIONS (A REVIEW). Rachinskii, V. V. (Agricultural Academy, Moscow). Zh. Anal. Khim.; 37: No. 5, 948-51(May 1972). (In Russian).

Investigations of the use of radiochromatographic analysis are briefly reviewed. The method has been developed in two main directions: the elaboration of the radiochromatographic methods of the study of sorbent properties (determination of sorption constants) and the use of radiochromatographic analysis in biochemistry of plants (photosynthesis chemistry, carbon and phosphorus exchange). Automatic radiometers are used for directly following the movement and distribution of traced components in chromatographic columns. (64 references) (auth)

58563 PAPER CHROMATOGRAPHY IN INORGANIC ANALYSIS (A REVIEW). Varshal, G. M. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 37: No. 5, 904-22(May 1972). (In Russian).

The literature on paper chromatography as a modern method of separation of multicomponent mixtures is reviewed. (198 references) (auth)

58564 THIN-LAYER CHROMATOGRAPHY OF INORGANIC IONS (A REVIEW). Volynets, M. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 37: No. 5, 871-82(May 1972). (In Russian).

The entity of the microchromatographic method in a thin layer of the sorbent on a plate is given; and the fundamentals of chromatographic separation of species, reagents, instruments, and experimental technique are described. Special attention is paid to some experimental varieties and means for the TLC technique to increase the efficiency of the method. Possible uses of TLC in inorganic and analytical chemistry are described, and prospects for development of the method are discussed. Literature data on qualitative and quantitative analysis of inorganic ions with the use of TLC are systematized. (auth)

58565 USE OF COLUMN PARTITION CHROMATOGRAPHY FOR SEPARATION OF INORGANIC SPECIES (A REVIEW). Katykhin, G. S. (Leningrad State Univ.). Zh. Anal. Khim.; 37: No. 5, 849-70(May 1972). (In Russian).

Papers on column partition chromatography published from 1964 to 1970 are reviewed. The solid supports used are compared, and future prospects of the method are considered. (309 references) (auth)

58566 SORPTION OF IONS OF Mo, W, AND Re ON ANION EXCHANGERS. Kazantsev, E. I.; Vasilenko, L. V.; Lekanov, L. P.; (and others) (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 2, 68-70(1972). (In Russian).

Fifteen relatively new brands of anion exchangers were tested for their ability and capacity to adsorb Mo, W, and Re ions from solutions characterized by a pH range of 3 to 9. Some of the resins showed promise for industrial separation processes. (K.S.W.)

58567 IMPURITY BEHAVIOR DURING THE EXTRACTION OF TELLURIUM BY TRIBUTYL PHOSPHATE. Tserekov, T. Kh.; Giganov, G. P.; Pashkov, G. L. Tsvetn. Metal.; No. 7, 60-3(Jul 1972). (In Russian).

The elements Se, As, Cu, Ag, Bi, and Pb were removed from HCl and H_2SO_4−HCl solutions of Te by TBP extraction. Scrubbing the extract by solutions of HCl and H_2SO_4 increased the separation of Cu and Ag up to 97% and As up to 90%. Separation of Te and Fe was realized through an extraction with 20% NH_4Cl solution. Washing the TBP phase with a H_2SO_4 solution removed additional Fe. The extraction technique described achieved a high-purity Te. (tr-auth)

58568 SORPTION OF GERMANIUM(IV) AND ZIRCONIUM(IV) ON ANION EXCHANGERS MODIFIED BY EDTA. Demetrashvili,

R. A.; Orlova, O. V.; Brouchek, F. I. (Georgian Polytechnic Inst., Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 68: No. 1, 69-72(Oct 1972). (In Russian).

The sorption of germanium(IV) and zirconium(IV) on the AH-2ΦΓ, AB-16 and AB-17 anion exchangers of the EDTA form was studied under dynamic conditions. The feasibility of applying these anion exchangers as sorbents of germanium(IV) and zirconium(IV) was ascertained. (auth)

58569 SEPARATION OF Mo AND Ru, Re AND Os, Au AND Pt BY COPRECIPITATION WITH FERRIC HYDROXIDE. Novikov, A. I.; Rustamov, S. (Tadzhik State Univ., Stalinabad, USSR). Dokl. Akad. Nauk Tadzh. SSR; 15: No. 4, 33-6(1972). (In Russian).

Methods are described for pH adjustment for optimum $Fe(OH)_3$ coprecipitation conditions to achieve separation of the following metal pairs (the second element of each pair remained in solution): Os–Re, Pt–Au, Ru–Mo. A method is described for separating ^{106}Ru + ^{106}Rh from Mo (pH 9, 1 M NH_4Cl); Os (pH 6.5 to 10); and Re and Pt from ^{198}Au (pH 9 to 14, 3 M NH_4Cl). (K.S.W.)

58570 THIN-LAYER CHROMATOGRAPHY OF INORGANIC IONS. IV. CHROMATOGRAPHY IN THE SYSTEM: SILICA GEL (IMPREGNATED WITH LIQUID CATION EXCHANGERS)–AQUEOUS HYDROCHLORIC ACID, NITRIC ACID, AND POTASSIUM THIOCYANATE SOLUTIONS. Muchova, A.; Jokl, V. (Comenius Univ., Bratislava). Chem. Zvesti; 26: No. 4, 303-8(1972). (In German).

Twenty four metal ions were chromatographed on silica gel layers impregnated with the liquid cation exchanger bis(2-ethylhexyl) phosphate. As eluents aqueous solutions of HCl, HNO_3, and KSCN were used in different concentrations. Plots of R_F and R_M values (latter for HCl and HNO_3 systems) vs. logarithm of eluent concentration are presented in the figures. Chromatographic behavior of the ions is discussed with respect to the ion exchange and complex-forming equilibrium. (auth)

58571 THIN-LAYER CHROMATOGRAPHY OF INORGANIC IONS. III. CHROMATOGRAPHY IN THE SYSTEM: SILICA GEL (IMPREGNATED WITH LIQUID ANION EXCHANGERS)–AQUEOUS SOLUTIONS OF ORGANIC COMPLEXING AGENTS. Muchova, A.; Jokl, V. (Comenius Univ., Bratislava). Chem. Zvesti; 26: No. 4, 289-302(1972). (In German).

The chromatographic behavior of eighteen metal ions on silica gel layers impregnated with liquid anion exchangers tri-n-octylamine and Amberlite LA-1 was investigated. As eluents the solutions of some hydroxy acids (lactic acid, tartaric acid, citric acid) and glycine in different concentrations and in different pH values were used as well as the solutions of complexones (iminodiacetic acid, nitrilotriacetic acid, hydroxyethyliminodiacetic acid, ethylenediaminetetraacetic acid) in the wide region of pH values. R_F values of ions vs. the concentration or pH value of eluents are presented in the figures. The results are discussed with special emphasis on the possibility of analytical utilization of investigated chromatographic systems. Examples of separations are mentioned. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 59219 and 59220.

58572 ISOTOPE EFFECT IN TRACER DIFFUSION. COMPARISON OF DIFFUSION COEFFICIENTS OF $^{24}Na^+$ AND $^{22}Na^+$ IN AQUEOUS ELECTROLYTES. Pikal, Michael J. (Univ. of Tennessee, Knoxville). J. Phys. Chem.; 76: No. 21, 3038-40(12 Oct 1972).

Experimental values of $D_{^{22}Na^+}/D_{^{24}Na^+}$ were determined in aqueous 0.1 N NaCl and in aqueous 10 m LiBr by allowing $^{24}Na^+$ and $^{22}Na^+$ to diffuse simultaneously in a diaphragm cell. The data indicate a small, but probably real, isotope effect on the order of a few tenths of 1%. It is concluded that an isotope effect of this magnitude is not consistent with the notion that the tracer diffusion coefficient of a species is inversely proportional to the square root of its mass. (auth)

Chemical and Physico-chemical Properties

Refer also to abstracts 58643–58645, 58654, 58660, 59161, and 59177.

58573 (AECL-4255) GS PROCESS PHYSICAL PROPERTIES. Galley, M. R.; Miller, A. I.; Atherley, J. F.; Mohn, M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug 1972. 152p. Dep. NTIS (U. S. Sales Only). AECL $3.00.

Physical properties of the H_2S-H_2O system were collated for use in calculations related to the Girdler–Sulfide (GS) process for heavy-water production. Graphs or tables of the values are presented together with sources and derivations where appropriate. (auth)

58574 CRYSTALLOGRAPHIC RADII OF BIVALENT CATIONS OF THE RARE-EARTH METALS. Finogenov, A. D. (Inst. of Semiconductors, Leningrad). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 2, 172-4(Feb 1972).

Translated from Zh. Fiz. Khim.; 45: No. 2, 286-9(Feb 1972).

Published crystallographic data for rare earth monochalcogenides were used to calculate the crystal radii of the bivalent cations. Lattice parameters were estimated for the chalcogenides of promethium and lutetium. The relation between crystalline and thermodynamic properties (standard enthalpies of formation) of sulfides of lanthanides in the cerium subgroup is shown to correspond to those for elements in the main subgroups of the Periodic System. (auth)

58575 ADSORBED OXYGEN INHIBITION OF REACTIONS OF HYDROGEN WITH TUNGSTEN. Gasser, R. P. H.; Morton, T. N.; Overton, J. M.; Ward, M. J. (Oxford Univ.). Nature (London) Phys. Sci.; 239: No. 89, 29-31(11 Sep 1972).

The effect of pre-adsorbed oxygen on the reactivity of a W filament with hydrogen and deuterium was studied. The "titration" technique for oxygenating the filament was employed (Nature 221 : 166 (1969) and 225 : 933 (1970)), and N_2O was used as oxygen source. Full experimental details of the work are given, and mechanisms are discussed. At higher temperatures an atomic mechanism is suggested, while near room temperature the participation of states of low binding energy is postulated. The effect of pre-adsorbed oxygen in producing the linear decline in reaction efficiency is attributed to a diminution in the surface area available, and "active sites" did not appear to play a significant part. No pressure dependence of hydrogen uptake could be detected. Adsorption experiments supported deductions made from isotope exchange results. (UK)

58576 AGGREGATION STUDIES OF SOME NUCLEAR MAGNETIC RESONANCE SHIFT REAGENTS BY VAPOR PHASE OSMOMETRY. Desreux, Jean F.; Fox, Lloyd E.; Reilley, Charles N. (Univ. of North Carolina, Chapel Hill). Anal. Chem.; 44: No. 13, 2217-19(Nov 1972).

The aggregation of chelates of Eu(III) and Pr(III) in a few typical solvents was studied by vapor phase osmometry. The data were interpreted with a computer program in terms of molecular associations via the Bjerrum relationship. (M.C.G.)

58577 SPECTROPHOTOMETRIC STUDY OF THE COMPOSITION OF Ru(IV) CHLORIDE COMPLEXES. Neikova, E. A.; Vassilev, C. Compt. Rend. Acad. Bulg. Sci.; 24: No. 12, 1641-4(1971). (In French).

The ionic form of Ru was determined as a function of the acidity of the medium, and the composition of the hydroxy-aquo complexes and their stability constants were ascertained. The absorption spectrum of a 7.35×10^{-5}M Ru solution with HCl concentration varying from 0.0002 to 5.0 M indicated the stepwise formation of a series of complexes between $[Ru(OH)_2(H_2O)_4]^{2+}$ and HCl: $[Ru(OH)_2(H_2O)_2Cl_2]$, $[Ru(OH)_2Cl_4]^{2-}$, and $[Ru(OH)Cl_5]^{2-}$. The neutral complex $[Ru(OH)_2(H_2O)_2Cl_2]$ exists at an acidity of about 0.17 M HCl, and explains its poor extraction by amines. (K.S.W.)

Isotope Effects

Refer also to abstract 58637.

58578 AN INVERSE β-DEUTERIUM ISOTOPE EFFECT IN THE SOLVOLYSIS OF A 1-AZABICYCLO[1.1.0]BUTANE. Gillard, Baiba K.; Kurz, Joseph L. (Washington Univ., St. Louis). J. Amer. Chem. Soc.; 94: No. 20, 7199-7201(4 Oct 1972).

The K_H/K_D = 0.948 is reported for the relative rates of acid-catalyzed hydrolysis of 3-phenyl-1-azabicyclo[1.1.0]butane and its 2,2-dideuterio analog. This isotope effect is consistent with a completely inductive or field transmission of the effect of β-deuterium substitution and places severe constraints on the kinds of bonding that can be present in the transition state. (D.H.M.)

58579 ORIENTATION DILEMMA IN ALKALINE HALOGENATION OF 2-BUTANONE. Swain, C. Gardner; Dunlap, Richard P. (Massachusetts Inst. of Tech., Cambridge). J. Amer. Chem. Soc.; 94: No. 20, 7204-5(4 Oct 1972).

The relative rates of H–O exchange of the hydrogen of 2-butanone in D_2O indicate that each enolizable methyl hydrogen (C-1,C-H) is no more electrophilic than each methylene hydrogen (C-3,C_3-H). In the NaOH-induced bromination of 2-butanone in aqueous solution at 25°C, each H on C-1 and C-3 is attacked equally fast (±5%) to form a sodium enolate, and the resulting 1-bromo-2-butanone and 3-bromo-2-butanone rapidly give bromoform, plus sodium propionate, and sodium lactate (via acetoin), respectively. (D.H.M.)

58580 EFFECT OF ADJACENT UNSHARED ELECTRON PAIRS ON EASE OF CARBANION FORMATION. Hine, Jack; Dalsin, Philip D. (Ohio State Univ., Columbus). J. Amer. Chem. Soc.; 94: No. 20, 6998-7002(4 Oct 1972).

The kinetics of sodium methoxide catalyzed deuterium exchange of methyl cyclopentanecarboxylate, two of its oxa derivatives, and their acyclic analogs were studied in methanol-O-d solution. At 35°C methyl cyclopentanecarboxylate exchanged 13 times as fast as methyl α-ethylbutyrate, methyl tetrahydrofuran-2-carboxylate exchanged four times as fast as methyl α-methoxybutyrate, and methyl 1,3-dioxolane-2-carboxylate exchanged half as fast as methyl dimethoxyacetate. From these results it was concluded that rates of carbanion formation may be decreased by repulsions between the unshared electron pairs of the carbanionic carbon atom and those of oxygen atoms attached directly to it. Such repulsions may be minimized by appropriate rotation around the carbon—oxygen bond in acyclic compounds but not as easily in cyclic compounds. This electron repulsion effect operates in addition to the electronegativity effect, by which rates of formation of sp^2-hybridized carbanions are slowed by highly electronegative atoms attached directly to the site of carbanion formation. This interpretation of the results is analogous to that required to explain recent observations on rates of pyramidal inversions at nitrogen and phosphorus. (auth)

58581 CRYSTAL STRUCTURE OF ClO_2 BY INFRARED AND RAMAN SPECTROSCOPY. Pascal, Jean-Louis; Pavia, Andre Claude; Potier, Jacqueline (CNRS, Montpellier, France). J. Mol. Struct.; 13: No. 3, 381-9(Sep 1972). (In French).

The infrared (4000 to 180 cm^{-1}) and Raman (1200 to 40 cm^{-1}) spectra of crystalline chlorine dioxide can be explained from similarities between ClO_2 and SO_2 (space group Aba (C_{2v}^{17})) and four molecules (site C_2) per unit cell. The assignments made were: ν_1 (A_1) 912 to 917 cm^{-1}, ν_1 (A_2) 939 to 944 cm^{-1}, ν_2 (A_1) 465 cm^{-1}, ν_2 (A_2) 456 to 459 cm^{-1}, ν_3 (B_1 and B_2) 1052 to 1121 cm^{-1}. The presence of four molecules per unit cell were corroborated by analysis of Raman lattice vibrations. Evidence for the isotopic $^{35}Cl-^{37}Cl$ effect was found in a partial study of liquid ClO_2. Dimerization is not possible in the solid state, and consequently it is forbidden in the other states. (auth)

58582 EXCHANGE REACTION OF METHANE-d_4 WITH HYDROGEN CHLORIDE. Kern, R. D.; Nika, G. G. (Louisiana State Univ., New Orleans). J. Phys. Chem.; 76: No. 20, 2809-17(28 Sep 1972).

A shock tube coupled to a time-of-flight mass spectrometer was used to study the exchange reaction, $CD_4 + HCl \rightleftharpoons CD_3H + DCl$, over a density range $1.7-4.1 \times 10^{-6}$ mol cm^{-3} in the temperature region 1600 to 2500°K. In the lower temperature range (1600 to 1900°K) DCl exhibits a quadratic time-dependent growth rate while at higher temperatures (2200 to 2500°K) increase of DCl is a linear function of time. The only chlorine-containing product is deuterium chloride. Rate constants extracted from the quadratic and linear regions yielded activation energies of 51 and 30 kcal mol^{-1}, respectively. An atomic mechanism for the exchange predicts both time dependences and the transition between them. Pyrolysis of methane occurred along with the exchange but the growth rate of the products ethane, acetylene, and diacetylene was shown not to be catalyzed by the presence of HCl. Acetylene was the major product of the pyrolysis. Exchange was observed in both major and minor products. The ratio $CH_3 : CH_4$ was less than one when pyrolysis products were not detected and greater than one when they were present. This finding suggests the presence of the methyl radical in the reaction mixture. The results are discussed in terms of an atomic mechanism. (auth)

58583 INFRARED SPECTRA OF TRIS(ETHYLENEDIAMINE) COBALT(III) COMPLEX ION IN SOLID STATE AND DISSOLVED IN LIGHT AND HEAVY WATER. Berg, Rolf W.; Rasmussen, Kjeld (Technical Univ., Lyngby, Denmark). Spectrosc. Lett.; 5: No. 10, 349-55(1972).

Studies are reported of the $[Co\ en_3]^{3+}$ ion. The accessible parts of the infrared spectra of nearly saturated solutions of the normal and N-deuterated salts in light and heavy water were measured. The spectra of $[Co\ en_3]Cl_3 \cdot 3\ H_2O$ in KBr disks were also measured. It was found that a remarkable number of bands are very similar in the crystalline state and in solution, with respect to wavenumbers, relative intensities, and band shapes. It was concluded that the internal vibrations of $[Co\ en_3]^{3+}$ cations are approximately independent of the crystal lattice. (D.H.M.)

58584 ISOTOPE EFFECTS IN PROTON TRANSFER FROM GENERAL ACIDS TO CARBON BASES. Kreevoy, Maurice M.; Eliason, Robert; Landholm, Richard A.; Straub, Thomas S.; Melquist, John L. (Univ. of Minnesota, Minneapolis). J. Phys. Chem.; 76: No. 21, 2951-3(12 Oct 1972).

As previously done for H^+ as the acid, isotope effects on proton transfer reactions from general acids to neutral, olefinic substrates were measured by conventional kinetic techniques in H_2O and D_2O and also by comparing the isotopic product ratio with the H : D ratio in the aqueous solvent. For monobasic acids, the two kinds of isotope effects are in satisfactory agreement after correction is made for the isotopic composition of the acidic proton. For H_3PO_4, an inverse, secondary, solvent isotope effect, like that observed in proton transfer from the aquated proton, is evident. (auth)

58585 VAPOR PRESSURE ISOTOPE EFFECT IN AQUEOUS SYSTEMS. III. THE VAPOR PRESSURE OF HOD (-60 to 200^0). Van Hook, W. Alexander (Univ. of Tennessee, Knoxville). J. Phys. Chem.; 76: No. 21, 3040-]3(12 Oct 1972).

The ratio $R = \ln (P_{H_2O}/P_{D_2O})/\ln (P_{H_2O}/P_{HOD})$ is evaluated from literature data on the vapor pressure isotope effects, boiling points, and freezing points of mixtures of the isotopic waters and is found to be 1.91 ± 0.02, in reasonable agreement with the value predicted with a cell model calculation. R_{liq} is constant within experimental error between 0 and 200° and over wide HOD concentration changes. The difference, $R_{liq}-R_{solid}$, is determined to be 0.02 from the freezing point data. (auth)

58586 HETEROAROMATIC HYDROGEN EXCHANGE REACTIONS. Pt. VI. ISOTOPE EFFECT FOR THE ACID-CATALYSED EXCHANGE OF SOME $3-{}^2H_1$- AND $3-{}^3H_1$-INDOLES. Challis, B. C.; Millar, E. M. (Imperial Coll. of Science and Tech., London). J. Chem. Soc., Perkin Trans., II; No. 11, 1618-24(1972).

Rates of deuterium and tritium displacement at 25°C from the 3-position of indole, 5-methoxyindole, and 5-cyanoindole are reported for various aqueous acetic acid buffer solutions, together with data for indole in aqueous pyridine buffers and for indole and 5-cyanoindole in dilute HCl. Deuterium is displaced more readily than tritium throughout, and the incidence of general acid catalysis suggests a common A-S_E2 exchange mechanism. Isotopic rate ratios computed from the experimental data for this pathway are substantial ($k_H/k_D = 4.5$ to 6.3) and show little systematic variation with the reactivity of either the substrate or the acid catalyst. Comparison with earlier data shows that the indole substrates are not exceptional in this respect and the size of the kinetic isotope effect appears to be an insensitive, if not unsatisfactory, index of transition state symmetry for aromatic hydrogen exchange reactions. Brønsted exponents for H_3O^+- and HOAc-catalysed exchange of these indoles are $\beta = 0.67$ and $\beta = 0.75$, respectively. Both are significantly larger than the Brønsted exponent obtained by the variation of the acid catalyst for exchange of 2-methylindole. (auth)

58587 HETEROAROMATIC HYDROGEN EXCHANGE REACTIONS. PT. VII. ISOTOPE EFFECTS FOR THE BASE-CATALYSED EXCHANGE OF $3-{}^2H_1$- AND $3-{}^3H_1$-INDOLES IN AQUEOUS SODIUM HYDROXIDE. Challis, B. C.; Millar, E. M. (Imperial Coll. of Science and Tech., London). J. Chem. Soc., Perkin Trans., II; No. 11, 1625-8(1972).

Rates of protodedeuteriation in aqueous NaOH at 25°C are reported for indole and 2-methylindole labelled at the 3-position, together with rates of deuteriodetritiation of the 2-methyl compound in NaOD. Calculation of various isotopic rate ratios from this and previous data for the corresponding protodetritiation reaction show unequivocally the incidence of an S_E2 mechanism involving the indole anion and water. Critical examination shows that the isotope effects for these reactions are relatively insensitive to the symmetry of the transition state for the proton-transfer process. (auth)

58588 ELECTRONIC SPECTRUM OF GASEOUS TeS. Barrow, R. F.; Dudley, M. A. H.; Hitchings, M. R.; Yee, K. K. (Oxford Univ.). J. Phys., B (London); 5: No. 8, L172-3(Aug 1972).

Bands assigned to TeS were observed in absorption in the region 3700 to 4000 Å and the rotational structure of 17 bands each of ^{128}TeS and ^{130}TeS was analysed. The bands arise from three systems $0^+ - xO^+$, in which the common lower state x is believed to be the $\Omega = 0^+$ component of the expected $^3\Sigma^-$ ground state. Constants for this state, in cm^{-1} for ^{130}TeS, are as follows: $\omega_e = 471.18$; $x_e\omega_e = 1.572$; $B_e = 0.13220$; $10^3\alpha_e = 0.545$. With $\mu(^{130}Tes) = 25.6574$ u, $r_e(x0^+) = 2.2293$ Å. The $\Omega = 1$ component of the ground state has not yet been observed. (auth)

58589 OPTICAL ACTIVITY DUE TO ISOTOPIC SUBSTITUTION. CIRCULAR DICHROISM OF (1R)-[2-^{18}O]-α-FENCHOCAMPHORONEQUINONE. Kokke, W. C. M. C.; Oosterhoff, L. J. (Univ., Lieden). J. Amer. Chem. Soc.; 94: No. 21, 7583-4(18 Oct 1972).

The synthesis of a diketone {(1R)-[2-^{18}O]-α-fenchocamphoronequinone}, which derives optical activity from substitution of one ^{16}O by ^{18}O, is reported. (D.H.M.)

58590 SECONDARY DEUTERIUM ISOTOPE EFFECTS FOR CARBONYL ADDITION REACTIONS. do Amaral, Luciano (Univ., Sao Paulo, Brazil); Bull, H. G.; Cordes, E. H. J. Amer. Chem. Soc.; 94: No. 21, 7579-80(18 Oct 1972).

Measurements were made of the α-deuterium isotope effects on both rates and equilibria for the addition of semicarbazide and phenylhydrazine to a series of substituted benzaldehydes. (D.H.M.)

58591 TYPE II PHOTOPROCESSES OF PHENYL KETONES. A GLIMPSE AT THE BEHAVIOR OF 1,4 BIRADICALS. Wagner, Peter J.; Kelso, P. A.; Kemppainen, A. E.; (and others) (Michigan State Univ., East Lansing). J. Amer. Chem. Soc.; 94: No. 21, 7506-12(18 Oct 1972).

Electron-donating groups on the benzene ring and electron-withdrawing groups at the δ, ϵ, and even ζ positions enhance quantum yields of type II photoreactions of phenyl alkyl ketones, whereas electron-withdrawing groups on the benzene ring and electron-donating groups at the γ and δ positions have the opposite effect. These effects are interpreted to reflect charge transfer from the γ-alkyl position to the oxygen in the transition state for reverse transfer of hydrogen back to the γ carbon, the major reaction of most 1-hydroxy 1,4 biradicals. Comparison of nonanophenone-γ,γ-h_2 with nonanophenone-γ,γ-d_2 indicates a k_H/k_D value of 1.35 for reverse hydrogen transfer in the biradical. Ring substituents and the length of the alkyl chain have little effect either on relative yields of cyclization and elimination or on cis/trans cyclobutanol ratios except where intramolecular hydrogen bonding can occur. For example, only trans-1-phenyl-2-(methoxymethyl)cyclobutanol is obtained from irradiation of δ-methoxyvalerophenone in benzene. In all cases the stereoselectivity of cyclization is lower in alcohol solvent than in benzene. As γ-alkyl substituents increase in size, the cis/trans cyclobutanol ratio surprisingly increases. α-Dimethyl substitution increases the cyclization/elimination ratio by a factor of ten, while β-dimethyl substitution decreases the ratio by a factor of ten. Kinetic analysis suggests that α-dimethyl substitution slows the rate of cleavage of the biradical while β-dimethyl substitution slows the rate of cyclization. These steric effects on biradical behavior are interpreted as reflecting restricted rotation in the biradical, such that cleavage and cyclization occur before rotational equilibrium is established. Pyridine and alcohols apparently do not enhance type II quantum yields in a kinetically controlled process. Rather a rapid equilibrium must be established between solvated and unsolvated biradicals. (auth)

58592 TYPE II PHOTOPROCESSES OF PHENYL KETONES. EVIDENCE FOR A BIRADICAL INTERMEDIATE. Wagner, Peter J.; Kelso, Philip A.; Zepp, Richard G. (Michigan State Univ., East Lansing). J. Amer. Chem. Soc.; 94: No. 21, 7480-8(18 Oct 1972).

Phenyl alkyl ketones generally undergo type II photoelimination and photocyclization solely from their lowest n,π^* triplet states. Photolysis of β,γ-diphenylbutyrophenone yields no triplet stilbene, which would be formed in a concerted elimination. It is concluded that γ-hydrogen abstraction to yield a 1,4 biradical is faster than the energetically allowed concerted elimination. It is suggested that the sequence triplet → biradical → products presents the facile path for T → S spin inversion which a concerted elimination cannot. Quantum yields for elimination, cyclization, and racemization of (4S)-(+)-4-methyl-1-phenyl-1-hexanone (I) total very close to unity. Added alcohol increases product quantum yields while decreasing racemization. The study of γ-deuterated phenyl n-octyl ketone reveals a k_H/k_D value of 4.8 for triplet state reaction. All this behavior would be expected from a biradical intermediate formed with 100% efficiency from the triplet and confirms earlier suggestions that low type II quantum yields in hydrocarbon solvents are caused by disproportionation of the biradical back to reactant ketone. In this regard, the total lack of any correlation between type II quantum yields and triplet-state lifetimes for different ketones makes sense only if quantum yields are determined solely by the partitioning of the biradical intermediates. Quenching and deuterium labeling studies reveal that alkyl thiols efficiently trap the biradicals from valerophenone and γ-methoxyvalerophenone, suggesting a solvated biradical lifetime $\sim 10^{-6}$ sec. Any trapping of the biradical from valerophenone by tributylstannane is hidden by the very rapid reduction of triplet ketone. A maximum value for the unsolvated biradical lifetime in heptane is estimated to be 2×10^{-7} sec. Some residual optical activity in cyclobutanols obtained from (+)-I suggests that the biradical does not live quite long enough to establish complete rotational equilibrium about the β,γ C—C bond. (auth)

58593 REACTIONS OF GENERAL BASES AND NUCLEOPHILES WITH BIS(p-NITROPHENYL) METHYLPHOSPHONATE. Brass, Herbert J.; Bender, Myron L. (Northwestern Univ., Evanston, Ill.). J. Amer. Chem. Soc.; 94: No. 21, 7421-8(18 Oct 1972).

Primary, secondary, and tertiary amines react with bis(p-nitrophenyl) methylphosphonate (b-p-NPMP) (I) via general base catalysis of water attack. The rate law is first-order in substrate and in amine. One mole of b-p-NPMP yields quantitatively 1 mole of p-nitrophenyl methylphosphonate (VI) and 1 mole of p-nitrophenol (p-NP) or its anion depending on pH. The rates of formation of VI and p-NP are identical. Solvent deuterium isotope effects, $k_2(H_2O)/k_2(D_2O)$, are greater than 2 for amine reactions. Different classes of amines follow a Bronsted relation with a slope of 0.38. s-Collidine falls below the Bronsted line but is as reactive as pyridine. Fluoride ion and several oxyanions react with I by a nucleophilic mechanism. At high fluoride ion concentration, 2 mole of p-NP is released in a first-order process. At lower fluoride concentrations less than 2 mole of p-NP is produced. II, a product of initial fluoride ion attack, can react with a second mole of fluoride or other bases in solution. p-Methoxyphenolate anion reacts with I in two kinetically separable reactions, releasing 2 mole of p-NP. Benzohydroxamate anion releases 2 mole of p-NP in a first-order process. Phosphate and hydroxide anions produce 1 mole of p-NP and VI probably in nucleophilic processes. $k_2(H_2O)/k_2(D_2O)$ for the reactions of fluoride and phosphate ions with b-p-NPMP ≅ 1.00—1.15. Steric crowding in the transition state can be invoked to explain the reactions of amines with I via a general base mechanism and the reactions of fluoride anion and oxyanions with I via a nucleophilic mechanism. (auth)

58594 MECHANISM OF AZOALKANE THERMOLYSIS. CONCERTED OR NONCONCERTED? Crawford, Robert J.; Takagi, Kunihiko (Univ. of Alberta, Edmonton.). J. Amer. Chem. Soc.; 94: No. 21, 7406-16(18 Oct 1972).

The synthesis and gas-phase thermolysis of the unsymmetrical azo compounds, methylazo-3-propene (6), 1-propylazo-3′-propene (7), and tert-butylazo-3-propene (8), are described. The nitric oxide inhibited rates of thermolysis of 6, 7, and 8 at 122.3° are compared with the rate of thermolysis of azo-3,3′-propene (5). It is concluded that the azoalkanes undergo thermolysis in the gas phase to produce two fragments in the rate-determining step. The secondary deuterium kinetic isotope effect of methylazo-3-propene-3,3-d_2 was determined, and the value obtained, k_H/k_D = 1.28 at 126.0° ($\Delta\Delta G^{\ddagger}$ per deuterium, 98 ± 15 cal mole^{-1}), is consistent with the formation of two fragments for both 5 and 6. (auth)

58595 CHEMICAL EVOLUTION OF A NITROGENASE MODEL. V. THE REDUCTION OF NITRILES. Schrauzer, G. N.; Doemeny, P. A.; Frazier, R. H. Jr.; Kiefer, G. W. (Univ. of California, San Diego, La Jolla). J. Amer. Chem. Soc.; 94: No. 21, 7378-85(18 Oct 1972).

Nitrogenase model systems, composed of molybdate and thiol ligands such as, e.g., cysteine, catalyze the reduction of aliphatic nitriles to alkanes and NH_3 in the presence of $NaBH_4$. The reaction is significantly stimulated by substrate amounts of ATP, is faster in D_2O than in H_2O, and is inhibited up to 90 and 41%, respectively, by CO and N_2 at 1 atm of partial pressure. Experiments with $^{15}N_2$ indicate that molecular nitrogen is reduced under these conditions, while CO apparently inhibits by forming a complex with the catalyst. The catalytically active species in the model systems are mononuclear molybdenum—thiol complexes. In the active reduced form molybdenum is probably in the 4+ oxidation state. The ATP stimulates the reduction of nitriles and of other substrates by accelerating the conversion of oxidized (i.e., Mo(V) and Mo(VI)) forms of the catalyst complexes to the active reduced form, by providing a better leaving group for the relatively inert molybdenum-bound OH groups. The initial interaction of the substrate with the catalyst is assumed to involve side-on bonding of the CN group, giving rise to the formation of an organomolybdenum species, whose subsequent reactions occur without Mo—C bond cleavage, until a terminal alkylmolybdenum complex is formed, whose hydrolysis yields the saturated hydrocarbon product plus the oxidized form of the catalyst. The reduction of unsaturated nitriles affords mixtures of alkanes and olefins in analogy to the reactions catalyzed by Azotobacter vinelandii nitrogenase. The olefinic organomolybdenum intermediates in this case undergo double bond and cis-trans isomerization prior to the hydrolysis of the molybdenum—carbon bond. The types of reaction of unsaturated nitriles are exemplified in detail for cis- and trans-crotononitrile as the substrate, also with catalyst systems containing 2-aminoethanethiol, glutathione, and bovine serum albumin as the thiol component. Since all previously observed reactions of nitriles with nitrogenase are essentially duplicated by the model systems, nitrile binding and reduction by nitrogenase must occur at the molybdenum active site of the Fe–Mo–protein of mole wt 270,000. Iron, which cannot replace molybdenum in the model system, exerts a modest cocatalyst effect. Its primary function in nitrogenase appears to be the activation of electron transport to the molybdenum active site. (auth)

Isotope Exchange and Isotope Separation

Refer also to abstract 58642.

58596 DEUTERIUM–HYDROGEN EXCHANGE USING DIAMINES. Bancroft, A. R.; Lockerby, W. E. (to Atomic Energy of Canada Ltd.). Canadian Patent 901,266. 30 May 1972.

Deuterium is extracted from a gaseous stream containing hydrogen gas by passing the stream through an exchange liquid. A diamine having up to five carbon atoms per molecule is used as the exchange liquid; suitable examples are 1,2-diaminoethane, 1,2-diaminopropane, and 1,3-diaminopropane. To enable relatively low exchange temperatures, eutectic mixtures of one of these diamines with another or with a monoamine can be used. The gaseous stream can be ammonia synthesis gas containing nitrogen and hydrogen in the approximate ratio of one to three by volume. (Canada)

58597 OXYGEN EXCHANGE REACTION OF PuO_2. Deaton, R. L.; Wiedenheft, C. J. (Monsanto Research Corp., Miamisburg, Ohio). J. Inorg. Nucl. Chem.; 34: No. 11, 3419-25(Nov 1972).

The oxygen exchange of PuO_2, prepared by the oxalate and hydroxide methods, was studied at temperatures between 700 and 1550°C. Large, dense particles were found to exchange much slower due to the presence of a diffusion controlled exchange process. However, diffusion becomes sufficiently rapid at 1550°C to allow a short equilibration time. (auth)

58598 EXPERIMENTAL STUDY OF CARBON ISOTOPE FRACTIONATION IN THE CH_4–C_2H_6–C_3H_8–C_4H_{10} SYSTEM AT DIFFERENT TEMPERATURES. Galimov, E. M.; Posyagin, V. I.; Prokhorov, V. S. (Inst. of Oil and Gas Industry, Moscow). Geokhimiya; No. 8, 977-87(Aug 1972). (In Russian).

Experiments were carried out to get an idea about the character and rate of the isotopic composition change of the $CH_4-C_2H_6-C_3H_8-C_4H_{10}$ system components at different temperatures. Two cases were investigated: a) hydrocarbons dissolved in oil at a 200 atm pressure and b) hydrocarbons that form a gas mixture in the presence of water vapors at an initial pressure of 1 atm. The mixture was maintained in autoclaves for 4 h at 25, 150, 300, 500°C. In both cases no change of the isotopic carbon composition occurred till 300°C; at 300°C traces of fractionation were noted, which attained an appreciable magnitude at 500°C. In the last case not only a redistribution of isotopes was observed, but also a depletion of each of the individual components in the ^{12}C isotope. This phenomenon was substantially more pronounced in the experiment with oil–gas mixture. The possible mechanism of reactions is considered; which explains the observed regularities as well as the rate of isotopic exchange in the investigated system under natural conditions. (auth)

Feed Materials Processing

Refer also to abstract 58671.

58599 (CEA-CONF-2021) TREATMENT OF EFFLUENTS FROM THE GUEUGNON FACTORY OF THE FRENCH ATOMIC ENERGY COMMISSION. Sugier, P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1972. 3p. (In French). (CONF-720454–1). Dep. NTIS (U. S. Sales Only).

From Meeting of the Mineral Section on problems posed by wastes arising from the processing of ores; Paris, France (19 Apr 1972).

A method was developed for treatment of the magnesium uranate preconcentrates, coming from Mounana (Gabon), in the Gueugnon factory. After reacting the preconcentrates with nitric acid, the effluents contain too much calcium nitrate to be disposed of after a simple calcium neutralization. A sulfuric acid treatment is used to produce insoluble calcium and nitric acid; the nitric acid is then reintroduced into the nitric reaction circuit. The operational scheme used is presented: evaporation, regeneration, and filtration. The economics of the process are studied together with its possible applications in other factories. (France)

Radiation Chemistry

Refer also to abstracts 58497, 58638, 58655, 58974, 59336, 60389, and 60404.

58600 (TID–26155) RADIATION CROSSLINKING OF POLYMERS WITH SEGREGATED METALLIC PARTICLES. Monthly Status Letter No. 13 (3rd Year). Corneliussen, R. D. (Drexel Univ., Philadelphia, Pa. (USA)). Jun 1972. Contract AT(11-1)-3035. 8p. Dep. NTIS.

58601 ON THE MECHANISM OF REDUCTION OF COBALT(III) AND RUTHENIUM(III) HEXAAMMINE COMPLEXES BY SEVERAL ALIPHATIC RADICALS. Cohen, H.; Meyerstein, D. (Nuclear Research Centre, Beersheba, Israel). J. Amer. Chem. Soc.; 94: No. 20, 6944-8(4 Oct 1972).

The specific rates of reaction of several aliphatic radicals with $Co(NH_3)_6^{3+}$ and $Ru(NH_3)_6^{3+}$ were determined. Radicals on the α carbon relative to OH or NH_2 groups were shown to be stronger reducing agents than radicals on the α carbon to a carboxylic or an amide group. The reactivity of the radicals $\dot{C}H_2OH$, $CH_3\dot{C}HOH$, $(CH_3)_2\dot{C}OH$, $CH_3\dot{C}OHCOO^-$, and $CH_3CO\dot{C}(O^-)CH_3$, toward $Ru(NH_3)_6^{3+}$ increases along this series, whereas the reversed order of reactivities is found for the reactions with $Co(NH_3)_6^{3+}$ and Cu_{aq}^{2+}. This order is different from the order of reactivities toward nitrobenzene and 2,3-butanedione where the reactivity increases along the series $CH_3\dot{C}OHCO_2^-$, $\dot{C}H_2OH$, $CH_3\dot{C}HOH$, and $(CH_3)_2\dot{C}OH$. The latter order is identical with that of increasing pK of the OH group. The results are interpreted as suggesting that the contribution of π character to the orbital containing the unpaired electron in the radical significantly affects the specific rates of reactions. The implication of the results in radiobiology is discussed. (auth)

58602 ENERGY-DEPENDENT RING OPENING OF CYCLOALKANE PARENT IONS. Sieck, L. W.; Gordon, R. Jr.; Ausloos, P. (National Bureau of Standards, Washington, D. C.). J. Amer. Chem. Soc.; 94: No. 20, 7157-9(4 Oct 1972).

Mass spectrometric results are reported that indicate that ring opening does occur in cyclopropane and that the fraction of parent ions that isomerize in this fashion reflects the internal energy content of the cyclic ion. It was tentatively concluded from the data presented that the fraction of $C_3H_6^+$ and $C_4H_8^+$ ions that transfer a proton to NH_3 or to other proton acceptors can be an accurate measure of the fraction of ions that exhibit an acyclic structure under particular conditions (pressure, temperature, etc.) of the experiment. Results of the study may be used to interpret radiation chemistry experiments. (D.H.M.)

58603 RADIOLYSIS OF WATER AS THE SOURCE OF FREE OXYGEN IN THE UNDERGROUND HYDROSPHERE. Gutsalo, L. K. (Inst. of the Geology and Geochemistry of Fossil Fuels, Lvov). Geochem. Int. (Engl. Transl.); 8: No. 6, 897-903(1971).

Translated from Geokhimiya; No. 12, 1473-81(1971).

Results for the Dnepr–Donets depression are used to show that free oxygen is present in Cl–Ca underground brines at depths of 2 to 3 km in reducing settings near oil and gas pools; calculations of partial pressures of O_2 demonstrate that the amounts substantially exceed those possible by solution from the atmosphere. The close correlation of the oxygen content with the dissolved Ra indicates that free oxygen is produced in situ by radiolysis of water. (auth)

58604 ELECTRONIC SPECTRA OF TRAPPED ELECTRONS IN ORGANIC GLASSES AT 4^0K: 3-METHYLPENTANE, 3-METHYLHEXANE, AND METHYLCYCLOHEXANE. Hase, Hirotomo (Kyoto Univ.); Higashimura, Takenobu; Ogasawara, Masaaki. Chem. Phys. Lett.; 16: No. 1, 214-16(15 Sep 1972).

The spectra of e_t^- produced in 3-MP (3-methylpentane) and MCH (methylcyclohexane) at 4°K were at longer wavelengths than those at 73°K, and shifted back to the same position as those produced at 73°K when the glasses were warmed to 73°K. The spectra in 3-MHX (3-methylhexane) at 4 and 73°K were the same. (auth)

58605 RADIATION-CHEMICAL SYNTHESIS OF ORGANOPHOSPHORUS COMPOUNDS. III. EFFECT OF ADDITIVES IN SMALL CONCENTRATIONS ON THE YIELD OF REACTION PRODUCTS FROM OLEFINS WITH PHOSPHORUS TRICHLORIDE. Babkina, E. I.; Vereshchinskii, I. V. (Inst. of Physical Chemistry, Moscow). Zh. Obshch. Khim.; 42: No. 6, 1285-8(Jun 1972). (In Russian).

Additions of benzene, CCl_4, and H_2O to mixtures of cyclohexene and PCl_3, after irradiation with gamma rays, double the yield of β-chlorocyclohexyldichlorophosphine at 25°C, and increase the yield by one fourth at 100°C. In the presence of Fe^{3+} salts the yield is reduced by 70 to 80%, and in the presence of Cu^+ or Cu^{2+} the reaction is inhibited completely. (K.S.W.)

58606 OPTICAL ABSORPTION OF SOLVATED ELECTRONS IN ALCOHOLS AND THEIR MIXTURES WITH ALKANES. Hentz, Robert R.; Kenney-Wallace, Geraldine (Univ. of Notre Dame, Ind.). J. Phys. Chem.; 76: No. 20, 2931-3(28 Sep 1972). (COO-38-851).

Absorption spectra were determined for the solvated electron in 22 alcohols and in binary mixtures of alcohols and cyclohexane.

Solutions were deaerated and irradiated with 5 or 10 nsec pulses of ~8-MeV electrons. Results suggest the binding and transition energies of e_s^- in the alcohols are determined by interaction of the electron with an optimum configuration of OH dipoles in a small solvation domain, perhaps a single shell, and that the optimum configuration for e_s^- is affected by molecular structure of the alcohol. (M.C.G.)

58607 ELECTRON SPIN RESONANCE SPECTRA OF DI- AND TRIMETHYLAMINIUM RADICALS. Fessenden, Richard W.; Neta, P. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 20, 2857-9(28 Sep 1972).

The ESR spectra obtained during radiolysis of acid solutions of di- and trimethylamine are shown to be due to the radicals $(CH_3)_2NH^{\dot{+}}$ and $(CH_3)_3N^{\dot{+}}$ formed by OH attack on the respective ammonium ions. The parameters that give the minimum rms error between observed and calculated positions are the following: for $(CH_3)_2NH^{\dot{+}}$, $a^N = 19.23$ G, $a^H_{NH} = 21.96$ G, $a^H_{CH_3} = 33.61$ G, and $g = 2.00354$ and for $(CH_3)_3N^{\dot{+}}$, $a^N = 20.55$ G, $a^H_{CH_3} = 28.56$ G, and $g = 2.00357$. The radical $(CH_3)_2NH^{\dot{+}}$ and its conjugate base $(CH_3)_2N\cdot$ were also produced by the reaction of e^-_{aq} with $(CH_3)_2NCl$. The pK for the dissociation of $(CH_3)_2NH^{\dot{+}}$ is estimated to be 6.5 to 7.5. (auth)

58608 ELECTRON SPIN RESONANCE EVIDENCE FOR DISSOCIATIVE ELECTRON CAPTURE IN γ-IRRADIATED PHOSPHATE ESTERS. Kerr, Carolyn M. L.; Webster, Kathleen; Williams, Ffrancon (Univ. of Tennessee, Knoxville). Contract AT(40-1)-2968. J. Phys. Chem.; 76: No. 20, 2848-50(28 Sep 1972). (ORO-2968-72).

Alkyl radicals are formed during γ irradiation of alkyl phosphates at 77°K. Inclusion of an electron scavenger virtually eliminates this reaction, and a comparable yield of radicals derived from the scavenger is obtained. This proves that alkyl radicals are formed only by dissociative electron capture in the pure esters. Possible biological implications are discussed. (auth)

58609 PARAMAGNETIC CENTERS IN OR ON VARIOUS OXIDES. Symons, M. C. R. (Univ. of Leicester, Eng.). J. Phys. Chem.; 76: No. 21, 3095-8(12 Oct 1972).

ESR data for some centers generally described as O^- were interpreted in terms of the V_K species O_2^{3-}, which is thought to be chemically more reasonable. The results for the g and ^{17}O A tensors are remarkably similar to those for the isoelectronic F_2^- center. A center, recently described as chlorine atoms absorbed on magnesium oxide, is shown to be better described as the V_K center ClO^{2-}. Other oxy centers of this type are also discussed. (auth)

58610 MODIFIED PRESCRIBED DIFFUSION IN RADICAL DIFFUSION KINETICS. Burns, W. G.; Curtis, A. R. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys. Chem.; 76: No. 21, 3008-12(12 Oct 1972).

An improved method of implementing the intention of Schwarz's modification of the Ganguly–Magee prescribed diffusion model, in which the Gaussian width parameter becomes a variable, is described. The improvement results in a shorter, more accurate program in which an arbitrary numerical factor is not required, and all functions are mathematically smooth. (auth)

58611 SPECTRA OF Na^-, K^-, AND e^-_{solv} IN AMINES AND ETHERS. Lok, Mei Tak; Tehan, Frederick J.; Dye, James L. (Michigan State Univ., East Lansing). J. Phys. Chem.; 76: No. 21, 2975-81(12 Oct 1972).

By using cyclic polyethers of the crown and cryptate classes to complex the alkali cations, alkali metals were dissolved in secondary amines and in straight and branched chain ethers. In the absence of the complexing polyether, the metals are insoluble in these solvents. Pronounced solubility enhancement occurred in primary mono- and diamines, tetrahydrofuran, and diethers in which the metals are only very slightly soluble without the complexing agent. The optical spectra of Na^-, K^-, and, in most cases, e^-_{solv} were measured for solutions in ethylamine, diethylamine, di-n-propylamine, 1,2-propanediamine, hexamethylphosphoric triamide, diethyl ether, diisopropyl ether, tetrahydrofuran, dimethoxyethane, and diglyme. In most cases the peak positions were measured as functions of temperature. For each of the three species the wave number of maximum absorbance decreased linearly with an increase in temperature. Linear correlations were found for the changes in the peak positions of e^-_{solv}, Na^-, and K^- with solvent at a given temperature. The spectra of Na^- and K^- obey the criterion for a charge transfer to solvent (ctts) transition that the position of the peak be a linear function of the temperature coefficient. However, no satisfactory correlation between the peak positions of Na^- and K^- and solvent properties was found. The spectrum of e^-_{solv} has now been determined by metal solution studies, as well as by flash photolysis and pulse radiolysis techniques, for the solvents ammonia, ethylenediamine, diethylamine, diethyl ether, tetrahydrofuran, dimethoxyethane, and diglyme. The agreement between the peak positions in all cases is good. However, in some cases the band is substantially broader in metal solutions than in those studied by radiolysis. (auth)

58612 EFFECT OF PRESSURE ON THE RADIATION-INDUCED POLYMERIZATION OF ETHYLENE IN TERT-BUTYL ALCOHOL. Wada, Takeshi; Watanabe, Terutaka; Takehisa, Masaaki (Japan Atomic Energy Research Inst., Takasaki). J. Polym. Sci., Part A-1; 10: No. 9, 2639-53(Sep 1972).

The effects of pressure on the radiation-induced polymerization of ethylene in tert-butyl alcohol were studied. The reaction was carried out by use of a reactor with a capacity of 100 ml under the following conditions; pressure, 60 to 400 kg/cm^2; temperature, 24 ± 3°C; dose rate, 2.0×10^4–1.6×10^5 rad/hr; amount of medium (tert-butyl alcohol containing 5 vol-% water), 70 ml. The results of polymerization were analyzed by a kinetical treatment based on a reaction mechanism with both first- and second-order terminations for the concentration of propagating radical. On the basis of the kinetical treatment the rate constants of each elementary reaction at several pressures were determined, and the activation volumes of elementary reactions were obtained and are discussed in connection with the reaction mechanism. Consequently, the rate constants of propagation, first-order termination, and second-order termination at pressure p and at 24°C were expressed by, $k_p = 50.5 \exp\{39p/297R\}$; $k_{t1} = 0.76 \exp\{28p/297R\}$; and $k_{t2} = 2.5 \times 10^3 \exp\{75p/297R\}$. (auth)

58613 γ-RADIOLYSIS OF ACETYLATED COTTON CELLULOSE: AN ESR STUDY. Chidambareswaran, P. K. (Cotton Technological Research Lab., Bombay); Sundaram, V.; Singh, B. B. J. Polym. Sci., Part A-1; 10: No. 9, 2655-60(Sep 1972).

The nature and behavior of free radicals induced in acetylated cotton celluloses irradiated with γ-rays were studied by electron spin resonance (ESR) spectroscopy. Dehydrogenation and deacetylation appear to be responsible for the free radicals observed from samples irradiated at 77°K. The degree of substitution enhanced the yield of acetyl radicals when the samples were irradiated at 77°K and adversely affected the overall radical concentration when irradiation was done at 300°K. In addition, the ESR spectra of samples irradiated under vacuum at 300°K were more intense than those obtained from samples irradiated in air. The nature, yield, and post-irradiation behavior of the primary radicals are discussed in the light of the ultimate chemical effects observed. (auth)

58614 RADIATION-INDUCED POLYMERIZATION OF GLASS-FORMING SYSTEMS. III. EFFECT OF MELTING POINT AND GLASS TRANSITION TEMPERATURE ON THE FORMATION OF THE GLASSY PHASE. Kaetsu, Isao; Okubo, Hiroshi; Ito, Akihiko; Hayashi, Koichiro (Japan Atomic Energy Research Inst., Takasaki). J. Polym. Sci., Part A-1; 10: No. 9, 2661-75(Sep 1972).

The general empirical rules about glass formation of organic compounds including monomers were studied. It was found that the difference of T_m (melting point) and T_g (glass transition temperature) was the most important factor in glass formation, that is, the glass-forming property of organic systems, mono-or multicomponent, could be expressed as a function of T_m and $T_m - T_g$ at the cooling temperature −196°C. The glass-forming property was further divided into four classes according to the relation between T_m and $T_m - T_g$, and each class was related to several patterns in DTA curves. From these results it was clarified that the phases are completely or partially glassified depending on the different values of $T_m - T_g$ in eutectic and noneutectic compositions. The overall phase diagrams covering the whole composition with the variation of T_m and T_g were determined, and they also supported the relationship between $T_m - T_g$ and the glass-forming property. The distinct glass-forming property of binary systems with large molecular interaction was attributed to the great lowering of T_m and elevation of T_g in those systems. The effect of the number of components on glass formation was also studied; it was shown that if T_m, T_g, and ΔH (sum of heat of melting and of mixing) are given, the number of components necessary to glassification can be estimated. (auth)

58615 SOLID-STATE POLYMERIZATION OF HEXAMETHYLCYCLOTRISILOXANE. II. Chawla, A. S.; St. Pierre, L. E. (McGill Univ., Montreal). J. Polym. Sci., Part A-1; 10: No. 9, 2691-2700(Sep 1972).

The solid-state polymerization of hexamethylcyclotrisiloxane was shown, by means of specific ion scavengers, to proceed by a cationic process. The reaction occurs at the crystal surface rather than within the lattice and exhibits a polymerization rate which is inversely proportional to the defect and negative ion concentrations in the crystalline monomer. (auth)

58616 NITRIC ACID OXIDATION OF IRRADIATED POLYETHYLENE. Bodily, David M. (Univ. of Utah, Salt Lake City). J. Polym. Sci., Part A-2; 10: No. 9, 1709-17(Sep 1972). (COO-1614-3).

Samples of high-density polyethylene were irradiated with x-rays and oxidized with concentrated nitric acid to determine the location of unsaturated groups. Vinyl groups initially present in the polymer were rapidly oxidized to the extent of 85% and are assumed to be excluded from the crystals. Vinylene groups show a rapid oxidation followed by slow oxidation. The initial oxidation is about 35%, which is slightly greater than the 25% amorphous content of the polymer prior to irradiation. Diene groups are rapidly oxidized by nitric acid but are formed at about the same rate in crystalline and amorphous samples. This is interpreted to indicate that diene groups are formed throughout the polymer but form large defects in crystalline regions and are accessible to oxidation. Defects formed in crystalline regions during irradiation lower the melting point to a greater extent than predicted by the mole fraction of noncrystallizable units. (auth)

58617 ESR STUDIES OF γ- AND ELECTRON-IRRADIATED POLY(VINYL CHLORIDE). Michel, R. E. (General Motors Corp., Warren, Mich.). J. Polym. Sci., Part A-2; 10: No. 9, 1841-4(Sep 1972).

ESR studies of both γ- and electron-irradiated poly(vinyl chloride) are described. Results indicate that similar radicals are stabilized in PVC at 77°K and in vacuo following exposure to both electron and γ radiation. The spectrum consists primarily of a septet that may arise from radicals associated with the dehydrochlorination process. (D.H.M.)

58618 EFFECTS OF GAMMA RADIATION ON VITAMIN B12 SYSTEMS. Blackburn, R.; Cox, D. L.; Phillips, G. O. (Univ. of Salford, Eng.). J. Chem. Soc., Faraday Trans., I; 68: No. 9, 1687-96(1972).

Cyanocobalamin and hydroxocobalamin react with both the oxidizing and reducing species produced by radiolysis of water. Reaction with OH radicals produces permanent degradation to yield a brown organocobalt compound. Reduction to vitamin B12r occurs by reaction with e_{aq}^- and this change can be reversed by the presence of oxygen. When OH radicals are scavenged by formate ion, the reducing species CO_2^- yields vitamin B12r. Oxygen and formate (10^{-1}M), therefore, protect the vitamin from permanent damage. The use of similar systems would allow the vitamin to be effectively sterilized in aqueous solution by ionizing radiation without accompanying chemical change. Otherwise, the more radiation resistant solid state should be employed, when G(cyanocobalamin) ~ 0.6. (auth)

58619 REDUCTION OF NITRATES BY THE IRRADIATION OF ALKALINE HYDROXIDE AND NITRATE MIXTURES IN MOLTEN AND SOLID STATES. Kalecinski, J.; Jezowska-Trzebiatowska, B. (Inst. for Low Temperature and Structure Research, Wroclaw). Radiochem. Radioanal. Lett.; 11: No. 5, 281-8(10 Oct 1972).

The γ-irradiation of alkaline hydroxides yields species that are able to reduce nitrate to nitrite. The yield is many times higher in molten than in solid state. It is also higher in KOH than in NaOH matrices. The nature of the reactive intermediates and the differences in yield are discussed. (auth)

58620 METHOD FOR GRAFTING ON POLYESTER FIBERS WITH RADIATION. Sakurada, Ichiro; Okada, Toshio (to Japan Atomic Energy Research Inst.). U. S. Patent 3,682,802. 8 Aug 1972. Priority date 6 Sep 1967, Japan.

A method is described for graft copolymerizing acrylic acid or methacrylic acid on polyester fiber by irradiation with ionizing radiation, comprising the addition of pyridine, 2-vinylpyridine, or 4-vinylpyridine to the reaction system to increase the rate and the effectiveness of the graft copolymerization. (Official Gazette)

58621 PROCESS FOR THE PREPARATION OF METHYL BROMIDE USING RADIATION. Asadorian, Arthur A.; Broadworth, Max R. (to Dow Chemical Co.). U. S. Patent 3,682,805. 8 Aug 1972. Filed 4 Sep 1969.

A process is described for the preparation of methyl bromide, which comprises refluxing methanol and bromine with exposure of the vapors to radiation of sufficient energy to activate the bromine. The process results in greater than 90% of the bromine employed being converted to methyl bromide. (Official Gazette)

58622 DEGRADATION OF POLY(VINYL CHLORIDE). II. KINETIC INVESTIGATION OF THERMAL AND RADIATION-INDUCED POLYENE FORMATION AT LOW TEMPERATURES. Palma, G.; Carenza, M. (CNR, Bologna). J. Appl. Polym. Sci.; 16: No. 10, 2485-2501(Oct 1972).

The degradation arising from purely thermal treatments as well as with accompanying exposure to γ-radiation was followed under vacuum by visible and ultraviolet spectroscopy in the temperature range from 80° to 130°C. As corroborated by extensive literature reports, absorbance changes were considered suitable to provide valuable information on the unsaturation sequences produced. In agreement with the results obtained in the same conditions by following the evolution of HCl, a catalytic action has been ascribed to HCl depending on the efficiency of removal of HCl. Furthermore, both the purely thermal and radiation-induced uncatalyzed degradations yield length distribution functions that are constant with time and have been found to be accounted for by the previously formulated free-radical mechanism, also from a quantitative point of view. (auth)

58623 RADIATION GRAFTING OF VINYL MONOMERS ONTO WOOD PULP CELLULOSE. II. Radi, F. S.; Hopfenberg, H. B.; Stannett, V. (North Carolina State Univ., Raleigh). J. Appl. Polym. Sci.; 16: No. 10, 2685-96(Oct 1972).

The effect of radiation dose rate and beating time on the mutual radiation grafting of styrene to unbleached and bleached kraft wood pulp was studied. Companion studies on the effect of beating time, peroxidation grafting, and order of monomer addition on the pre-irradiation graft copolymerization of acrylamide and diethylaminoethyl methacrylate were conducted on bleached wood pulp. The grafting rate of styrene increased with dose rate, but the kinetics suggests a significant diffusional resistance to the observed grafting rate. The per cent graft measured at fixed grafting conditions decreased markedly as pulp beating (effected prior to grafting) was increased. It is suggested that the decrease in grafting with beating is due to an increase in the accessibility and swelling of the beaten fibers. Dimethylaminoethyl methacrylate appeared to inhibit the grafting of acrylamide, and double grafting had to be used to graft both hydrophilic polymers to the pulp. The mechanical properties of high-yield pulp and groundwood were improved by the addition of the grafted pulps. The double grafts appeared to show promise as fibrous beaten additives for dry strength improvement. The styrene-grafted pulps were found not to respond at all to the beating process. (auth)

58624 TREATMENT OF SEWAGE. Spragg, Hal R. (to United States Atomic Energy Commission). U. S. Patent 3,677,935. 18 Jul 1972. Filed 4 May 1964.

A method is described for treating sewage by irradiation with 10^3 to 10^6 rad of ionizing radiation from x- or gamma sources, thereby increasing the sedimentation rate of the sewage and degrading organic sewage components, especially synthetic detergents. Radioactive isotopes are the preferred sources of the ionizing radiation. (Official Gazette)

58625 RADIOLYSIS OF ANILINE. Knight, J. A. (Georgia Inst. of Tech., Atlanta). Radiat. Res.; 51: No. 3, 590-8(Sep 1972). (ORO-3519-10).

Gamma irradiation of aniline yields as products hydrogen, ammonia, benzene, diphenylamine, the isomeric aminobiphenyls, the isomeric aminodiphenylamines, and the isomeric diaminobiphenyls. Nitrogen, acetylene, hydrazine, hydrazobenzene, and the diaminobenzenes were not detected as radiolytic products. The relative reactivities for γ-induced phenylation of aniline are 6.7 : 1 : 8.3 for the ortho : meta : para positions. Radioinduced phenylation at the amino group is about 14 times as great as on the phenyl ring. If the aminodiphenylamines are formed by the reaction of the ortho, meta, and para reactive species of aniline with the amino group of aniline, then the relative reactivities for the generation of these reactive species are 4.5 : 1 : 11. From results with naphthalene, anthracene, biphenyl, and TMPD as additives, approximately 50% of the yields of ammonia and diphenylamine could be related to the excited solvent molecules formed by a very fast process, and the other portion of the yields could not be related to any specific precursors. The yield of hydrogen was not affected by any of the additives. The results of the additives on the benzene yield were not conclusive in relation to the formation of benzene. (auth)

58626 ELECTRON SPIN RESONANCE STUDIES OF ELEMENTARY PROCESSES IN RADIATION- AND PHOTO-CHEMISTRY. Pt. II. RADICAL REACTIONS OF α-AMINOBUTYRIC ACID BETWEEN 26 AND 440K. Ayscough, P. B.; Olsen, K. J. (Univ. of Leeds, Eng.). J. Chem. Soc., Faraday Trans., I; 68: No. 9, 1635-46(1972).

Irradiation of α-aminobutyric acid single crystals with ^{60}Co γ rays at 26 to 77°K results in the trapping of the protonated molecular-anion $CH_3CH_2CH(NH_3^+)CO_2H^-$(R1). During thermal annealing to 440°K, six further radicals are formed including $CH_3CH_2\dot{C}HCO_2H$(R4), $\dot{C}H_2CH_2CH(NH_3^+)CO_2^-$(R2), $CH_3\dot{C}HCH(NH_3^+)CO_2^-$(R3) and $(CH_3)_2\dot{C}CO_2H$(R7). The conversion of R1 to R4 and then to R2 and R3 occurs between 100 and 145°K by processes involving only 8 to 17 kJ mol^{-1} "activation" energy and determined largely by steric considerations. The conversion of R3 to R7 was followed isothermally between 330 and 365°K and the decay of R7 between 390 and 430°K. These processes have "activation" energies of 71 ± 7 and 83 ± 5 kJ mol^{-1} respectively and are likely to involve some translational motion of the radicals. A possible mechanism for the radiolysis is discussed. (auth)

58627 γ-RADIOLYSIS OF DIETHYL SUCCINATE. Mills, K. J.; Peto, J. M. N. (Guy's Hospital Medical School, London). J. Chem. Soc., Faraday Trans., I; 68: No. 9, 1626-34(1972).

Diethyl succinate was irradiated under vacuum with ^{60}Co γ-radiation. An attempt was made to identify and measure the complete product spectrum. Twenty different products were found after a maximum total dose of 9×10^{23} eV l^{-1}. The most abundant were ethanol, ethyl propionate, ethane, hydrogen, carbon monoxide, acetaldehyde and carbon dioxide. With the possible exception of acetaldehyde, G-values for these products were independent of the dose in the range studied. Gas yields were also measured in the presence of small amounts of additives ($FeCl_3$, H_2O or $CH_2:CH_2$). Possible mechanisms for product formation are discussed. (auth)

58628 ELECTRON PARAMAGNETIC RESONANCE AND ELECTRON NUCLEAR DOUBLE RESONANCE OF THE AsO_4^{4-} CENTRE IN X-IRRADIATED KH_2AsO_4. Dalal, N. S.; McDowell, C. A.; Srinivasan, R. (British Columbia Univ., Vancouver, Can.). Mol. Phys.; 24: No. 2, 417-39(Aug 1972).

Electron paramagnetic resonance studies of the AsO_4^{4-} centre in x-irradiated crystals of KH_2AsO_4 in the ferroelectric phase at 77 and 4.2°K are reported. The symmetry of the spin-hamiltonian was found to be orthorhombic, and the g tensor and the A tensor describing the interaction of the unpaired electron with the arsenic nucleus ($I = ^3/_2$) were obtained. Domain splitting was observed in the spectra recorded in the ab plane of the crystal. By studying these spectra in the presence of an applied electric field, it has been possible to plot the hysteresis curve of ferroelectric KH_2AsO_4. Electron-nuclear double resonance (ENDOR) of protons surrounding the AsO_4^{4-} units was studied at 4.2°K. Two sets of ENDOR lines were found arising from the protons in the two equilibrium positions (labelled "close" and "far") along the hydrogen bonds linking the AsO_4 tetrahedra. The angular variation of the ENDOR lines from both "close" and "far" protons was plotted in the crystal symmetry planes. The observed ENDOR frequencies were fitted to those calculated from the numerical diagonalization of the Hamiltonian. The superhyperfine parameters for the "close" and "far" protons thus obtained are found to be quite anisotropic. The ENDOR results are shown to explain all details of the partially-resolved proton superhyperfine structure at room temperature as well as at low temperatures. An isotropic contact hyperfine coupling of –2,875 MHz of the unpaired electron to the proton in the "far" position of the hydrogen bond was determined, providing direct evidence for covalency in the hydrogen bonding in KH_2AsO_4 crystals. (auth)

58629 ELECTRON SPIN RESONANCE SPECTRUM OF X-IRRADIATED PHENYLPHOSPHINIC ACID AND ITS SALTS. Geoffroy, M.; Lucken, E. A. C. (Univ., Geneva). Mol. Phys.: 24: No. 2, 335-40(Aug 1972).

Irradiation of single crystals of phenylphosphinic acid $C_6H_5P(H)(O)OH$, gives rise to a radical to which the structure $C_6H_5P(O)OH$ is ascribed. The radical exists in four different symmetry-related orientations and the average principle values of the g-tensor and of the ^{31}P coupling tensor are 2.0023, 2.0034, 2.0034 and 1865, 1346, 1320 MHz. Irradiation of the polycrystalline acid gives identical results for the ESR parameters. Irradiation of various polycrystalline salts of phenylphosphinic acid gives rise to spectra attributed to $C_6H_5PO_2^{-}\cdot$, the phosphorus analogue of the nitrobenzene radical anion. The ESR parameters are similar to those of the radical arising from the corresponding acid but vary with the nature of the cation. They indicate that unlike $C_6H_5NO_2^{-}\cdot$ the radical is non-planar and has the unpaired electron largely localized on the phosphorus atom. (auth)

58630 ANALYTICAL STUDIES OF FRACTIONS FROM IRRADIATED LYSOZYME. Marciani, Dante J.; Tolbert, Bert M. (Univ. of Colorado, Boulder). Biochim. Biophys. Acta; 271: No. 2, 262-73(1972).

Dry lysozyme (mucopeptide N-acetylmuramylhydrolase, EC 3.2.1.17) irradiated in vacuo with 26 Mrad of γ rays was fractionated with NaCl in presence of 0.1 M acetic acid. Gel chromatography of the heavily damaged salt-insoluble fraction, F-I, revealed the presence of species with larger hydrodynamic volume than native lysozyme. The salt-soluble fraction, F-II, showed a gel chromatography elution pattern similar to that of native lysozyme. Molecular weight determinations by sodium dodecyl sulfate polyacrylamide gel electrophoresis of F-I indicated the presence of altered monomers and polymers formed by integral multiples of monomeric lysozyme. F-II is formed mainly by monomers with solubility and hydrodynamic properties similar to those of native lysozyme. Reduced and alkylated irradiated lysozyme showed a single band on dodecyl sulfate electrophoresis corresponding to monomeric lysozyme, indicating that the polymers are formed by intermolecular disulfide bonds. F-I showed 0.42 to 0.48 carbonyl groups per molecule; however, no fragmentation of the polypeptide chain was detected. An increase in ammonia was observed for F-I components subjected to several fractionation steps, indicating a decomposition of damaged groups and/or a slow hydrolysis of exposed amide groups. It is proposed that heavily damaged molecules with exposed disulfide bonds can undergo a free radical polymerization initiated by $-CH_2S\cdot$ radicals. (auth)

58631 SELF-RADIOLYSIS OF TRITIATED COMPOUNDS. IV. UNSATURATED FATTY ACID ESTERS. Colosimo, M.; Guarino, A. (Univ., Rome). J. Label. Compounds; 8: No. 2, 257-77(1972).

The self-radiolysis of methyl oleate-9, 10-T was studied under different conditions of storage, i.e. under vacuum, in solution of benzene, of n-pentane, and of cyclohexene. The influence of the storing conditions on the total yields of decomposition, as well as on the different self-radiolysis products formed, is discussed taking into account the processes and mechanisms observed in the radiation chemistry of this, and similar compounds. (auth)

58632 METHOD OF PREPARING MERCAPTANS USING HIGH ENERGY RADIATION. Kochanny, Gerald L. Jr. (to Dow Chemical Co.). U. S. Patent 3,682,804. 8 Aug 1972. Filed 13 Nov 1969.

A method is described for preparing mercaptans by commingling olefins and H_2S with small amounts of a liquid ketone and subjecting the mixture to high-energy radiation, such as gamma rays. (Official Gazette)

Radiochemistry and Nuclear Chemistry

Refer also to abstracts 60182–60184, 60186, and 60213.

58633 (MLM–1960) EARLY HISTORY OF RADIOCHEMISTRY. Kirby, H. W. (Mound Lab., Miamisburg, Ohio). 22 Sep 1972. Contract AT-33-1-GEN-53. 126p. Dep. NTIS.

The development of radiochemistry is traced from the discovery of radioactivity in 1896 through its climax in 1913, when the concept of isotopes made it possible to squeeze more than 30 new radioactive "elements" into the half-dozen remaining vacancies at the end of the Periodic Table. The procedures first employed to isolate many of the radioelements are described in detail, frequently through the use of direct quotations from the original research publications. Each stage in the development is documented so that those wishing to examine a particular discovery in more detail can do so with the aid of more than 200 references to primary sources. (auth)

Hot-Atom Chemistry

Refer also to abstract 60185.

58634 (COO–1713-36) REACTION STUDIES OF HOT SILICON AND GERMANIUM RADICALS. Progress Report, September 1, 1971–August 31, 1972. Gaspar, Peter Paul (Washington Univ., St. Louis, Mo. Dept. of Chemistry). 1972. Contract AT(11-1)-1713. 17p. Dep. NTIS.

Research progress is reported on primary reactions of recoiling ^{31}Si atoms, $^{31}Si^{+}$ ion intermediates, implication of ion–molecule reactions for recoil studies of silicon atom reactions, reactions of recoiling ^{75}Ge, and reactions of hydrogen atoms with silane and germane. (M.C.G.)

58635 RATIO OF TERMINAL TO CENTRAL ADDITION OF FLUORINE ATOMS TO PROPYLENE. Williams, Ronald L.; Iyer, R. Subramonia; Rowland, F. S. (Univ. of California, Irvine). J. Amer. Chem. Soc.; 94: No. 20, 7192-4(4 Oct 1972).

The addition of fluorine atoms to propylene was studied with the reaction sequence being: formation of ^{18}F atoms in SF_6 by the (n,2n) nuclear reaction; moderation of their initially high kinetic energy by collisions with excess SF_6; addition to propylene; and identification of the radical adducts, usually after subsequent abstraction of H from HI. The yields of the major volatile ^{18}F-containing products from such reactions are summarized. The ratio of terminal/central addition in propylene is 1.35 ± 0.02. (D.H.M.)

58636 HYDROGEN DISPLACEMENT IN n-BUTANE BY FAST T_2 COLLISIONS. Menzinger, Michael (Univ. of Toronto); LeRoy, Rodney L.; Yencha, Andrew J.; Wexler, S. J. Phys. Chem.; 76: No. 20, 2937-40(28 Sep 1972).

Beatty and Wexler data on cross sections for tritium molecular beam reactions with n-butane are discussed. Interpretation of results in terms of a multiple collision process is discussed. It is questioned whether the conditions for applicability of the kinetic theory are met. Answers to these comments are given. (M.C.G.)

58637 PHOTOCHEMICAL PRODUCTION OF HOT HYDROGEN AND DEUTERIUM ATOMS. REACTIONS WITH HYDROGEN HALIDES AND HALOGENS. Fass, Richard A.; Hoover, John W.; Simpson, Linda M. (Pomona Coll., Claremont, Calif.). J. Phys. Chem.; 76: No. 20, 2801-8(28 Sep 1972).

The reactions of photolytically produced hot hydrogen and deuterium atoms with hydrogen halides and halogens were studied in both moderated and unmoderated gas-phase systems. The ratios of the rates of the reactions $H + HX \rightarrow H_2 + X$ (2) and $H + X_2 \rightarrow HX + X$ (3) were determined when HX is HBr, DBr, and HCl, and the results were compared with similar data available in the literature for HCl, DCl, and HI. In the absence of inert gas moderators the ratios k_3^*/k_2^* for the reactions of hot atoms are 5.6 ± 0.25 for HBr, 6.7 ± 0.13 for DBr, and 8 ± 4 for HCl. The data for D atoms from the photolysis of DBr in the presence of D_2 moderator ($[D_2]/[DBr] > 70$) give $k_3/k_2 = (12 \pm 2.8) \exp (0.9 \pm 0.16)/RT$. (auth)

58638 MECHANISM OF SCAVENGING REACTIONS IN IRRADIATED BENZENE SOLUTIONS OF TRIS(ACETYLACETONATO)CHROMIUM(III). Tominaga, T.; Nishi, Y. (Tokyo Univ.). Radiochem. Radioanal. Lett.; 11: No. 5, 289-95(10 Oct 1972).

Acetylacetonates of magnesium and nickel were found to enhance the thermal reactions in neutron-irradiated benzene solutions of Cr/acac/$_3$ on standing. A probable mechanism is proposed to explain the effects of metal salts and acetylacetonates as additives on the thermal reactions of ^{51}Cr recoil species in the irradiated solutions. (auth)

58639 TESTS OF THE INDEPENDENCE HYPOTHESIS IN BROMINE–CARBON TETRACHLORIDE SOLUTIONS. Collins, K. E.; Collins, C. H.; Kapauan, P. A. (Philippine Atomic Research Center, Quezon City). Radiochem. Radioanal. Lett.; 11: No. 5, 297-302(10 Oct 1972).

Organic bromide parent molecules give ^{80g}Br-organic yields about 15% higher than Br_2 parent molecules after the ^{80m}Br(IT) ^{80g}Br transformation in bromine-carbon tetrachloride solutions. On the other hand, no significant differences were seen when the ^{82m}Br(IT)^{82g}Br transition, a one-step transformation, and the ^{80m}Br(IT)^{80g}Br transition, a two-step transformation, are compared in the same solutions. The differences from organic (carbon-bromine) parents and inorganic (Br–Br) parents may be due to geminate recombination reactions. (auth)

58640 CHEMICAL REACTIONS OF NUCLEAR RECOIL PARTICLES IN GASES AND LIQUIDS. Urch, D. S. (Queen Mary Coll., London). pp 149-212 of Radiochemistry. /Maddock, A. G. (ed.). London; Butterworths (1972).

A review is presented of chemical reactions of nuclear recoil particles in gases and liquids that includes experimental techniques; theory (slowing down of recoil particles, reactions mechanics, calculation of reaction cross-sections, and general description of recoil particle reactivity); reactions of recoil tritium; reactions of recoil fluorine; reactions of recoil bromine; and reactions of recoil iodine. (356 references) (D.H.M.)

58641 REACTIONS OF THE HELIUM TRITIIDE ION WITH LIQUID ARENES. Cacace, F.; Caronna, S. (Univ., Rome). J. Chem. Soc., Perkin Trans., II; No. 11, 1604-7(1972).

The reactivity of the HeT^+ ion from the β decay of molecular tritium to benzene and toluene was investigated in the liquid phase. It is suggested that the tritiodeprotonation occurs via a mechanism based on the exothermic triton transfer from HeT^+ to the arene, leading to the formation of an excited arylium ion followed by its collisional stabilization and by a thermoneutral proton transfer to another molecule of substrate. The attack of the HeT^+ reagent is characterized by the complete lack of substrate selectivity, as expected for an extremely reactive free cation carrying a net positive charge of unity. On the other hand, despite its extreme electrophilic character, the reagent retains a remarkable positional selectivity. The implications of these findings are discussed, and the behavior of the HeT^+ ion is compared with that of poorly solvated "ionic" reagents, obtained with conventional techniques, towards the same substrates in non-polar solvents. (auth)

58642 ORGANIC RADIOPHARMACEUTICALS LABELED WITH ISOTOPES OF SHORT HALF-LIFE. V. ^{18}F-LABELED 5- AND 6-FLUOROTRYPTOPHAN. Atkins, H. L.; Christman, D. R.; Fowler, J. S.; (and others) (Brookhaven National Lab., Upton, N. Y.). J. Nucl. Med.; 13: No. 10, 713-19(Oct 1972).

The synthesis of ^{18}F-labeled 5- and 6-fluorotryptophan is discussed. The ^{18}F was introduced as ^{18}F-labeled fluoroborate from ^{19}F(p,pn)^{18}F or as ^{18}F-fluoride produced by the irradiation of a water target with ^{3}He. Animal experiments using these compounds are also described. (D.H.M.)

Properties of Radioactive Materials

Refer also to abstracts 58542, 58558, 58574, 58631, 59061, 59133, and 59161.

58643 (CONF-720931-1) SOME SELECTED TOPICS IN ACTINIDE, TRANSACTINIDE, AND SUPERHEAVY ELEMENTS RESEARCH AT OAK RIDGE. Keller, O. Lewin Jr. (Oak Ridge National Lab., Tenn.). 1972. 28p. Dep. NTIS.

From Symposium on the chemistry of the transuranium elements; Moscow, USSR (4 Sep 1972).

Chemical properties of transactinide elements are being studied and predicted. The approach to Element 111 chemistry is discussed. Valence state predictions, spin-orbit interactions, hyperfine splittings arising from the interaction of the nuclear magnetic moment with the electronic magnetic moment, valence states of Np, and application of photoelectron spectroscopy to studies of the actinides are considered. (M.C.G.)

58644 ENTROPIES OF FUSION OF THE ELEMENTS IN RELATION TO MENDELEEV'S PERIODIC LAW. Glazov, V. M. (Moscow Inst. of Electronic Engineering). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 3, 348-51(Mar 1972).

Translated from Zh. Fiz. Khim.; 46: No. 3, 606-11(Mar 1972).

On the basis of Mendeleev's Periodic Law and modern concepts concerning the changes in short-range order and in the nature of the chemical bonds of the elements on fusion, the entropies of fusion of the elements were examined and the characteristics of the functional relation $\Delta S \cong f(z)$ (z is the atomic number in Mendeleev's Table) are explained. Higher entropies of fusion were noted for elements in which the type of chemical bonding changes on fusion. A rigorous periodicity in the variation of the entropies of fusion has been demonstrated and on this basis the entropies of fusion of technetium, polonium, astatine, francium radium, and actinium are predicted. (auth)

58645 INFRARED SPECTROSCOPIC STUDY OF THE MECHANISM OF THE SORPTION OF METAL IONS ON COMPLEX-FORMING RESINS. IV. INFRARED SPECTRA OF SG-1 RESIN CONTAINING URANIUM. Chuveleva, E. A.; Yufryakova, N. K.; Nazarov P. P.; Chmutov, K. V. (Inst. of Physical Chemistry, Moscow). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 2, 227-9(Feb 1972).

Translated from Zh. Fiz. Khim.; 46: No. 2, 391-4(Feb 1972).

The infrared spectra of SG-1 resin were investigated as a function of the content of the second and third complexes of uranium in the sorbent. The change of the relative peak intensities of the bands characterizing the vibrations of different types of bonds between the carboxylate ion and uranium is largely determined by the change of the stability constant of the third uranium complex. (auth)

58646 NONBREAKABLE NUCLEAR MAGNETIC RESONANCE SAMPLE CONTAINER FOR RADIOACTIVE MATERIALS. Crisler, L. R. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Appl. Spectrosc.; 26: No. 5, 560-2(1972).

A simple nonbreakable sample container was designed for insertion into a standard glass NMR tube. The ^{1}H and ^{19}F signals for the NMR spectrum of tetrakis(hexafluoroacetonato)uranium (IV) in benzene-d_6 obtained by use of the insert are shown. (M.C.G.)

58647 MECHANISM AND RULES OF THE CHLORINATION OF METAL WITH CHLORINE IN THE PRESENCE OF CARBON MONOXIDE. Ketov, A. N.; Gaisinovich, M. S.; Burmistrova, E. V.; Kostin, L. P.; Kolesov, I. M. Izv. Vyssh. Ucheb Zaved., Tsvet. Met.; No. 2, 38-43(1972). (In Russian).

The oxides of 30 metals were chlorinated with a Cl_2-CO mixture at elevated temperatures, frequently in the range where the formation of phosgene was appreciable. At the lower reaction temperatures (200 to 500°C) the solid products were usually solid chlorides, carbonates, or oxychlorides. At the higher chlorination temperatures (500 to 900°C) the liquid products were usually chlorides or oxychlorides, with frequent appearance of gaseous products such as $TiCl_4$, $ZrCl_4$, $HfCl_4$, $VOCl_3$, $NbOCl_3$, and $NbCl_5$ plus, of course, CO_2. The reactions observed were characterized as endo- or exothermic. The sole radioactive element included in this study was the chlorination of ThO_2 at 505°C to form solid $ThOCl_2$ and gaseous CO_2. (K.S.W.)

58648 OXIDATION-REDUCTION REACTIONS IN THE UO_3–$MoCl_5$ SYSTEM. Eliseev, S. S.; Glukhov, I. A.; Vozhdaeva, E. E. (Inst. of Chemistry, Stalinabad, USSR). Dokl. Akad. Nauk Tadzh. SSR; 15: No. 7, 37-40(1972). (In Russian).

The following systems were studied by means of thermogravimetric analysis: $UOCl_3-MoCl_5$, $UO_2Cl_2-MoCl_5$, and UO_3-MoCl_5. The degree to which each was exothermic was noted. An oxidation–reduction reaction was observed between UO_3 and $MoCl_5$ at 200°C; the U going to the IV state in the stable compound UCl_4. (K.S.W.)

58649 FORMATION OF SOLUBLE URANATES BY HYDROLYSIS OF URANYL(VI) IONS. Musikas, C. (CEA, Fontenay-aux-Roses, France). Radiochem. Radioanal. Lett.; 11: No. 5, 307-16(10 Oct 1972). (In French).

The reaction between UO_2^{2+} and OH^- ions leads to soluble anionic complexes when tetrabutylammonium hydroxide is used as base. Potentiometric and spectrophotometric measurements show that $UO_2(OH)_4^{2-}$ is obtained above pH 13. For lower pH values polymeric species with (OH^-/U) ratio smaller than 4 are observed. When (OH^-/U) is two, $UO_2(OH)_2$ precipitates. (auth)

58650 ADDUCTS OF URANIUM TETRAHALIDES WITH N-DONOR LIGANDS AND PROPERTIES OF THE OCTATHIOCYANATOURANATE(IV) ANION IN A CUBICAL CONFIGURATION. Gans, P.; Marriage, J. (Univ. of Leeds, Eng.). J. Chem. Soc., Dalton Trans.; No. 16, 1738-41(1972).

Electronic spectra and magnetic measurements are reported for some new adducts of uranium tetrachloride and uranium tetrabromide with aromatic, alicyclic, and aliphatic amines; and for some previously reported amine adducts of uranium tetrachloride and also for the compound $[(Et_4N)_4][U(NCS)_8]$ in which the anion has a cubical configuration. The data suggest that the adducts with pyridine and piperidine may have an unusual configuration. (auth)

58651 DIVALENT AMERICIUM. THE CRYSTAL STRUCTURE AND MAGNETIC SUSCEPTIBILITY OF AmI_2. Baybarz, R. D. (Oak Ridge National Lab., Tenn.); Asprey, L. B.; Strouse, C. E.; Fukushima, E. J. Inorg. Nucl. Chem.; 34: No. 11, 3427-31(Nov 1972).

The preparation and identification of divalent americium, as AmI_2, are reported. Lattice constants for the monoclinic AmI_2 are $a_0 = 7.677 \pm 0.003$ Å, $b = 8.311 \pm 0.004$ Å, $c = 7.925 \pm 0.003$ Å and $\beta = 98.46 \pm 0.03°$. The effective magnetic moment for AmI_2 is $\mu_{eff} = 6.7 \pm 0.7$ BM. AmOI was also prepared, and the lattice constants for the tetragonal cell are $a_0 = 4.011 \pm 0.002$ Å and $c = 9.204 \pm 0.007$ Å. (auth)

58652 COMPLEXING OF TRIVALENT ACTINIDE IONS BY GLYCOLATE. Choppin, G. R.; Degischer, G. (Florida State Univ., Tallahassee). J. Inorg. Nucl. Chem.; 34: No. 11, 3473-7(Nov 1972).

The thermodynamic parameters are reported for the formation of the monoglycolato complex of Am(III), Cm(III) and Bk(III) in an ionic medium of 2.0 M ($NaClO_4$). The values agree within experimental error with those for the analogous complexes of the lanthanide ions of comparable ionic radii. (auth)

58653 CALCULATION OF THE FREQUENCIES AND FORM OF NORMAL VIBRATIONS OF THE URANYL FLUORIDE ANION COMPLEX $(UO_2F_5)^{3-}$. Fang Tun K'eng; Komyak, A. I. Zh. Prikl. Spektrosk.; 16: No. 6, 1052-6(Jun 1972). (In Russian).

The frequencies and normal vibration forms of $(UO_2F_5)^{3-}$ were calculated. Frequency manifestation in the low-temperature luminescence spectra was explained on the basis of a theoretical analysis. Approximation of force constants was made with an algorithm, and the final results showed good agreement of calculated and experimental frequencies and good reliability in the initially chosen approximation on the dynamic coefficients. (tr-auth)

58654 SYNTHESIS AND CHELATING PROPERTIES OF CARBOXYLIC DERIVATIVES OF AROMATIC AMINES. Piotrowska, Hanna; Serafinowa, Barbara; Wejroch-Matacz, Krystyna; Trybulowa, Zofia; Boguszewska, Zofia (Polytechnical Univ., Warsaw). Rocz. Chem.; 46: No. 7-8, 1323-33(1972). (In Polish).

A series of polycarboxyanilines and polycarboxy-2,2'-diaminodiphenyls and their derivatives were prepared and their chelating properties towards copper, mercury, lead, iron, and in some cases uranyl, zirconium, and samarium, were tested. Good complexing properties were shown among the aniline derivatives by amides and by hydrazides that very easily form complexes with mercury ions. Hydrazide forms also complexes with ferric ions. Hydrazide of the malonic derivative of 2,2'-diaminodiphenyl forms very stable complexes with mercury ions. (auth)

58655 STUDY ON AUTORADIOLYSIS OF TRITIATED NUCLEOSIDES. Kopoldova, J.; Dedkova, V. (Biological Inst., Prague). J. Label. Compounds; 8: No. 2, 207-19(1972).

The autoradiolytic decomposition of thymidine–6–T and uridine–5–T in aqueous solution at +2 and –15°C, in ethanol, and on chromatographic paper was studied in dependence on time of storage and specific activity. (auth)

58656 NON-EXCHANGE SYNTHESIS OF TRITIUM-LABELED TETRAHYDROCANNABINOLS. Gill, E. W.; Jones, G. (Oxford Univ.). J. Label. Compounds; 8: No. 2, 237-48(1972).

Tritium-labelled (-)-$\Delta^{1(16)}$ and (-)-Δ^1-tetrahydrocannabinols at a specific activity of 607 mCi/mmole were synthesized by a nonexchange method. The tritium was introduced by the catalytic reduction with tritium gas of an unsaturated precursor of dimethyl olivetol in hexafluorobenzene as a nonexchanging solvent. Specifically labelled olivetol was subsequently used in the synthesis of (-)-Δ^1-tetrahydrocannabinol by an established method. The radiochemical purity of the product was shown to be greater than 98% by TLC, GLC, liquid scintillation counting, and bioassay. (auth)

58657 SPECIFIC TRITIUM LABELING OF α-(p-METHOXYPHENYL)-α'-NITRO-4[3-(DIMETHYL-AMINO)-PROPOXY] STILBENE(CI-680) BY CATALYTIC DEIODINATION. Blackburn, C. E. (Mallinckrodt Chemical Works, St. Louis). J. Label. Compounds; 8: No. 2, 279-92(1972).

In an unusual example of tritium-labelling by catalytic dehalogenation in the presence of competing groups, an iodinated precursor was selectively deiodinated with tritium gas to yield α-(4-methoxyphenyl-3-^{3}H)-α'-nitro-4[3-(dimethyl-amino)propoxy] stilbene (CI-680-^{3}H). The product was labelled specifically at the C-3 position of the methoxyphenyl moiety with a specific radioactivity of 27.7 Ci/mmole and a net yield of 609 mCi. Characterization of CI-680-^{3}H (base) established the chemical purity to be >99% and the radiochemical purity to be ≥97.6%. Characterization also included an evaluation of the tritium label stability in water and in aqueous acidic and basic media. (auth)

58658 BIOSYNTHESIS OF ^{75}Se-SELENOMETHIONINE FOR USE IN SCINTIGRAPHY. Conti, L. (CEN de Saclay, Gif-sur-Yvette, France); Hegesippe, M.; de Saint-Sauveur, S.; Tempe, J. Int. J. Appl. Radiat. Isotop.; 23: No. 9, 415-21(Sep 1972). (In French).

A semi-industrial method of preparation by biosynthesis of ^{75}Se-selenomethionine is described. The original technique of Blau (Radiology. 78; 974(1962)) has been modified, firstly to avoid the noxious effects of solvents and acid solutions on the laboratory equipment, secondly to increase the yield and to improve the purification step. The radioactive yield is about 25%. The product obtained has a high specific activity (>100 mCi/mg) and is radiochemically pure. The final solution contains isoleucine and leucine as chemical impurities which have no influence on the use of that product in scintigraphy. (auth)

Radioactive Waste Treatment

Refer also to abstract 58599.

58659 (KFK-1500) DECONTAMINATION OPERATIONS DEPARTMENT ANNUAL REPORT, 1970. Krause, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Jun 1972. 137p. (In German). Dep. NTIS (U. S. Sales Only).

BITUMINOUS MATERIALS—radioactive waste fixation in
CEMENTS—leaching radioactive waste from
DECONTAMINATION—research progress on
FISSION PRODUCTS—diffusion in glass and rock salt
—fixation by thermite reactions
METALS—decontamination of surfaces of
NITRIC ACID—decomposition of
PHOSPHORIC ACID, TRIBUTYL ESTER—processing of contaminated
RADIOACTIVE WASTE—processing of
—fixation in bitumin
—leaching from cement
—disposal of low-level, in salt mines
SALT DEPOSITS—radioactive waste disposal in (M.C.G.)

58660 ION-EXCHANGE EXTRACTION OF IODINE FROM WASTE WATERS OF CERTAIN PROCESSES. Shcherban, G. T.; Bronnikova, N. V.; Kletsman, M. V. J. Appl. Chem. USSR (Engl. Transl.); 45: No. 3, 678-9(Mar 1972).

Translated from Zh. Prikl. Khim.; 45: No. 3, 668-70(Mar 1972).

The exchange capacity of the ÉDÉ-10P resin to 100% breakthrough of iodine ions during extraction of these ions from waste waters containing various amounts of iodides and organic substances was determined. The exchange capacity increased with increasing iodide content in waste waters. Increase in the content of organic matter in waste waters from 5 to 100 mg/l did not affect the exchange capacity. (M.C.G.)

Radioisotope Production

Refer also to abstract 60222.

58661 (JPRS-57175) FORMATION OF ^{46}Sc DURING THE IRRADIATION OF CALCIUM IN HIGH-ENERGY NEUTRON BEAMS. Levin, V. I.; Malinin, A. B.; Kurchatova, L. N. Translated from Radiokhimiya; [14:] No. 3, 447-50(1972). 8p. NTIS.

In preparations of ^{45}Ca obtained by irradiation of targets of natural isotope composition and enriched with ^{44}Ca, an impurity of ^{46}Sc was observed. The magnitude of this impurity increased in a nonlinear way with the intensity of the neutron flux and amounted to about 1% of the activity of ^{45}Ca during irradiation for 175 days in a neutron flux of 1.5 × 10^{14} n/cm^2 per second. The formation of ^{46}Sc in calcium targets occurs as a result of the secondary capture of the neutron: $^{44}\mathrm{Ca}(n,\gamma)^{45}\mathrm{Ca}^{1\beta^-} \rightarrow {}^{45}\mathrm{Sc}(n,\gamma)^{46}\mathrm{Sc}$ Calculations of the accumulation of ^{46}Sc, performed in accordance with this scheme, coincided well with the experimental data. A method was developed for purifying the ^{45}Ca preparations from ^{46}Sc by passing a solution of the irradiated target in hydrochloric acid (with an excess of 0.1 to 1.0 n HCl) through a column filled with granulated fluoroplast coated with a film of bis(2-ethylhexyl) phosphate. (auth)

58662 USE OF A COMPACT, MULTI-PARTICLE CYCLOTRON FOR THE PRODUCTION OF ^{52}Fe, ^{67}Ga, ^{111}In, AND ^{123}I FOR MEDICAL PURPOSES. Dahl, J. R.; Tilbury, R. S. (Sloan-Kettering Inst. for Cancer Research, New York). Int. J. Appl. Radiat. Isotop.; 23: No. 9, 431-7(Sep 1972).

Methods of production of ^{52}Fe, ^{67}Ga, ^{111}In and ^{123}I using a small medical cyclotron are described and discussed. The methods of preparing targets by electroplating are described as well as the design and operation of the internal target probe. Yields, impurities, and chemical separation procedures are described in detail. (auth)

58663 NOVEL PREPARATION OF HIGH SPECIFIC ACTIVITY RADIONUCLIDES. Collins, K. E.; Catral, J. C.; Toh, W. T.; Detera, S. D.; Kapauan, P. A. (Philippine Atomic Research Center, Quezon City). Radiochem. Radioanal. Lett.; 11: No. 5, 303-5(10 Oct 1972).

The promotion of α- to β-transformation of metal phthalocyanines by "crystallizing solvents" can be used to produce radionuclides at high enrichment with satisfactory yields. ^{64}Cu and ^{65}Zn were prepared using this method. (auth)

58664 PRODUCTION OF THE RADIOISOTOPE ^{111}In WITHOUT A CARRIER BY THE IRRADIATION OF CADMIUM BY PROTONS. Gureev, E. S.; Islamov, T.; Usachenko, V. S. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 1, 87-90(1972). (In Russian).

A method was developed for producing radioisotopes without a carrier, by irradiating a target with 18-MeV protons in a cyclotron. Natural Cd was used as the target in a (p,n) reaction (10 μA for 10 hr), to yield the following In isotopes: 108, 110, 111, 112, 114, 116. The corresponding (p,2n) reaction would yield 109, 110, and 111. The target was dissolved in HCl and ^{111}In was chromatographically separated. (K.S.W.)

58665 SUPERHEAVY ELEMENTS. Jech, Cestmir (Ustav Fysikalni Chemie, Prague). Chem. Listy; 66: No. 8, 785-99(Aug 1972). (In Czech).

Predicted nuclear stability and properties of superheavy elements (Z > 105) are reviewed, processes possibly responsible for their origin in nature discussed, and results of experimental search for their presence in nature summarized. Reviewed are also nuclear reactions suggested for artificial production of superheavy elements and experimental results obtained in this field. (26 references). (auth)

58666 CARRIER-FREE ISOLATION OF INDIUM FROM SILVER AND CADMIUM BY LIQUID-LIQUID EXTRACTION. Wood, R. A.; Wakakuwa, S. T.; MacDonald, N. S. (Univ. of California, Los Angeles). J. Inorg. Nucl. Chem.; 34: No. 11, 3517-22(Nov 1972).

An analytical method was developed for the rapid and carrier-free separation of 2.81d ^{111}In produced by the reactions $^{109}\mathrm{Ag}(^4\mathrm{He},2n)^{111}\mathrm{In}$ and $^{110}\mathrm{Cd}(d,n)^{111}\mathrm{In}$. The method is based on the fact that indium in the presence of macro-concentrations of Ag(I) and Cd(II) preferentially extracts into n-heptane solutions of bis(2-ethylhexyl) hydrogen phosphate (HDEHP) from aqueous nitric acid media. The Ag(I) and Cd(II) remain quantitatively in the aqueous phase. The distribution ratios (K) vary from greater than 10^3 for In(III) to less than 10^{-2} for Ag(I) and Cd(II). The indium is quantitatively stripped from the solvent phase with HCl. The total separation time is less than 10 min. K was studied with respect to acid-solvent dependence, equilibration, and back extraction. Optimum conditions for maximum extraction were determined. (auth)

58667 SHORT-LIVED ISOTOPES OF LANTHANUM, CERIUM, AND PRASEODYMIUM IN NEUTRON IRRADIATED URANIUM. Ohyoshi, A. (Univ. of Kumamoto, Japan); Ohyoshi, E.; Tamai, T.; Shinagawa, M. J. Inorg. Nucl. Chem.; 34: No. 11, 3293-3302(Nov 1972).

The separation of fission product La, Ce, and Pr was performed within 90 to 180 sec by electromigration. As a supporting electrolyte, the solution of nitrilotriacetic acid ([NTA] = 3.7 × 10^{-3} M, pH = 2.0, μ ~ 0.05) was used. Rapid location of the zone on the paper strip reached after migration was obtained by color reaction of the carrier added to the irradiated uranyl nitrate solution. The γ spectrum of each element was measured by a Ge(Li) detector connected with 512 channel pulse-height analyzer. In the lanthanum fraction, at early times two prominent photopeaks at 395 keV ($T_{1/2}$ = 40 ± 2 sec) and 541 keV ($T_{1/2}$ = 43 ± 3 sec) were observed. From their decay rates, it was presumed that they could be attributed to ^{144}La ($T_{1/2}$ = 41 sec) whose γ energies have not yet been reported. The two other photopeaks at 619 and 642 keV were assigned to the 14 min ^{143}La and 92 min ^{142}La. In the Ce fraction, the photopeaks assigned to the 3 min ^{145}Ce and to the 14 min ^{146}Ce were observed, while no photopeaks could definitely be assigned to the 65 sec ^{147}Ce. Some unreported γ rays of ^{145}Ce were found to be 233, 300, 429, and 915 keV. In the Pr fraction, the 2.0 min ^{148}Pr (γ energy = 300 keV) and 12 min ^{147}Pr (the photopeaks at 123 and 313 keV) were identified. (auth)

58668 PRODUCTION OF CARRIER-FREE ^{123}I USING THE $^{127}\mathrm{I}(p,5n)^{123}\mathrm{Xe}$ REACTION. Fusco, M. A.; Peek, N. F.; Jungerman, J. A.; (and others) (Univ. of California, Davis). J. Nucl. Med.; 13: No. 10, 729-32(Oct 1972).

A cyclotron procedure for the production of high-purity, carrier-free ^{123}I suitable for immediate radiopharmaceutical use was developed. Proton irradiation of natural elemental iodine results in the production of ^{123}Xe which subsequently decays to ^{123}I. The primary reaction for 57-MeV protons is $^{127}\mathrm{I}(p,5n)^{123}\mathrm{Xe}$; other reactions yield ^{125}Xe and the neutron-deficient radioisotopes of iodine. At the end of bombardment, the target iodine is dissolved in aqueous KI, and helium gas is bubbled through the solution sweeping the xenon through a recirculating system. The xenon gas is collected in a liquid nitrogen-cooled trap. The isolated xenon is contained for 6 hr during which time the ^{123}Xe ($T_{1/2}$, 2.1 hr) decays to ^{123}I. The ^{123}I may be recovered by adding a small volume of physiological saline. An irradiation on the Crocker Nuclear Laboratory isochronous cyclotron of 1 hr, using a 1 gm/cm^2 thickness of iodine (7-MeV proton energy loss in the target) and 57.5-MeV protons at 6 μA, resulted in 24 isolable mCi of ^{123}I. The only detectable contaminant in the final product was ^{125}I which was about 0.1% of the ^{123}I activity. (auth)

58669 FEASIBILITY STUDY OF ^{99m}Tc PRODUCTION ON A MEDICAL CYCLOTRON. Lebowitz, Elliot (Brookhaven National Lab., Upton, N.Y.). J. Nucl. Med.; 13: No. 10, 776-7 (Oct 1972).

In support of a feasibility study of ^{99m}Tc production on a medical cyclotron reported by Beaver, et al. (J. Nucl. Med. 12: 739-741, 1971) some copper nuclear-reaction cross sections were measured. The values reported are in agreement with the reference values used in the study by Beaver, et al. (D.H.M.)

58670 SEPARATION AND RECOVERY OF AMERICIUM FROM CURIUM AND OTHER ELEMENTS. Moore, Fletcher L. (to United States Atomic Energy Commission). U. S. Patent 3 687,641. 29 Aug 1972. Filed 9 Mar 1971.

A method is provided for the separation of americium from curium dissolved in a dilute aqueous solution of nitric acid, which comprises selectively oxidizing the americium to the 5+ oxidation state, passing the resultant solution through a porous packed column of crystalline zirconium phosphate, and then selectively eluting an americium-containing solution. (Official Gazette)

Reactor Fuel Reprocessing

Refer also to abstracts 58779, 59362, and 60516.

58671 (CONF-720836-1) NUCLEAR FUEL CYCLE. Brooksbank, R. E. (Oak Ridge National Lab., Tenn.). 1972. 41p. Dep. NTIS.

From Energy source for the future symposium; Oak Ridge, TN. (18 Aug 1972).

Specific plant operating experiences in parts of the cycle and regulatory means now used to control the prime operational areas of the fuel cycle and to minimize their potential insult to the public from a health and safety standpoint are outlined. Uranium ore processing, production of UF_6, enrichment of ^{235}U, conversion to UO_2, and fabrication are discussed. Fuel reprocessing is also considered. Hazards potentials in fuel transport, reprocessing, fuel preparation, and waste handling are discussed. An oxide conversion line used to provide ceramic-grade $^{233}UO_2$ is described. Six years of operational experience in reprocessing by Nuclear Fuel Services at West Valley, New York are reviewed. Manpower requirements for the fuel cycle are considered. Future nuclear fuel cycle problems are postulated. (M.C.G.)

58672 (CONF-720928-1) ELEMENTS OF HIGH-TEMPERATURE GAS-COOLED REACTOR FUEL REPROCESSING. Wymer, R. G. (Oak Ridge National Lab., Tenn.). 1972. 25p. Dep. NTIS.

From Tennessee Industries Week conference; Knoxville, TN. (11 Sep 1972).

It is postulated that there will exist a reprocessing capacity requirement of about 9.5 metric tons of uranium-plus-thorium per day in the year 2000. General steps in reprocessing HTGR fuels are outlined. The separation of ^{235}U from ^{233}U particles is one of the principal steps in reprocessing. Burner feed preparation, fuel element burning, particle classification, off-gas decontamination, and uranium and thorium separation and purification are discussed. (M.C.G.)

58673 (DOCKET-50268-35) MIDWEST FUEL RECOVERY PLANT. Cask Tipping Incident. (General Electric Co., San Jose, Calif. Nuclear Fuel Dept.). 27 Sep 1972. 13p. (DOCKET-701308-1). Dep. NTIS.

This Amendment No. 31 is submitted in response to AEC Staff questions on a fuel cask tipping incident that occurred on June 12, 1972. Topics covered include: inleakage, cells affected, flow rates and pathways, disposition of water that could not be accounted for and sampling techniques, and proposed design and application of basin liner protection. (M.C.G.)

58674 (DOCKET-50268-36) MIDWEST FUEL RECOVERY PLANT. Applicant's Environmental Report, Supplement 1, Errata and Addenda Sheet 1. (General Electric Co., San Jose, Calif. Nuclear Fuel Dept.). 22 Sep 1972. 8p. Dep. NTIS.

58675 METHOD FOR REPROCESSING MOLTEN FLUORIDE SALT REACTOR FUELS. Whatley, Marvin E. (to United States Atomic Energy Commission). U. S. Patent 3,677,719. 18 Jul 1972. Filed 9 Mar 1971.

An improved method for reprocessing molten fluoride salt reactor fuels containing protactinium is provided comprising a dual temperature reductive extraction process using as an extractant molten bismuth containing a metal reductant. In the improved process the fuel values and the metal reductant are the only extractables. (Official Gazette)

58676 HYBRID SIMULATION OF A MULTISTAGE LIQUID EXTRACTION SYSTEM FOR A MULTICOMPONENT MIXTURE. Di Bartolomeo, M. (CNEN, Rome); Gallo, R.; Papalia, B. pp 308-13 of Conference on Hybrid Computation. Brussels; Presses Academiques Europeenes (1970).

From sixth conference on hybrid computation; Munich, Germany (31 Aug 1970). See CONF-700826.

A hybrid simulation model of a mixer-settler extractor, which is a unit of fundamental use in nuclear fuel reprocessing plants to separate first uranium and plutonium from fission products, and then uranium from plutonium, is presented. The analog circuit of one stage is iteratively used for all the stages by means of the digital computer which is employed for function storage and playback. As the flow is in counter-current the boundary conditions are satisfied with a relaxation procedure, that is the iterative solution for all the stages is repeated until the convergence is reached. (auth)

58677 SYNERGIC SOLVENT EXTRACTION OF LANTHANIDES WITH MIXTURES OF ALIPHATIC FLUORINATED β-DIKETONES AND ORGANOPHOSPHORUS DONORS. Mitchell, J. W.; Banks, C. V. (Ames Lab., Iowa). Talanta; 19: No. 10, 1157-69(Oct 1972).

The extraction of lanthanides from an aqueous acetate-chloride medium into cyclohexane solutions of trifluoroacetylacetone, hexafluoroacetylacetone, 6,6,7,7,8,8,8-heptafluoro-2,2-dimethyl-3,5-octanedione, and tri-n-butyl phosphate was studied. The extraction properties of other fluorinated aliphatic β-diketones and fluoroorganophosphates were also investigated. The efficiency of the extraction of the lanthanides, the composition of the complexes transferred to the organic phase and the extraction and stability constants for the synergic reactions were determined. Synergic extraction, as a technique for the preparation of lanthanide species, was evaluated for compatibility with subsequent gas chromatography. The lanthanides were found to be rapidly and quantitatively transferred into organic phases containing mixtures of fluorinated aliphatic β-diketones and TBP. The resulting mixed complexes that contained fully fluorinated β-diketones had a distinct stoichiometry and were thermodynamically more stable than similar mixed complexes of partially fluorinated β-diketones. These properties of the synergic systems allow precise control of the formation of anhydrous complexes in the organic phase and are compatible with the use of these systems for gas chromatography. (auth)

58678 MIXING AND SETTLING SEPARATION PROCESS FOR URANIUM OR PLUTONIUM. Walsh, William J.; Pierce, Robert Dean (to United States Atomic Energy Commission). U. S. Patent 3,677,743. 18 Jul 1972. Filed 3 Jun 1969.

A process and apparatus for separating fission products from uranium and/or plutonium employing liquid metals and liquid salts as solvents are disclosed. A solution of uranium and/or plutonium in a liquid metal is flowed sequentially into and through a plurality of mixer-settlers containing a liquid salt, which remove certain fission products from the feed solution as well as a small proportion of the uranium and/or plutonium. The uranium and/or plutonium are removed from the feed solution in another mixer-settler and the liquid metal solvent is recycled to the first mixer-settler where it washes all of the uranium and/or plutonium from the liquid salt present therein. The liquid salt in the first mixer-settler is discarded, the liquid salt in subsequent mixer-settlers is transferred between stages and fresh liquid salt is added to the last mixer-settler. Also disclosed is a system including a plurality of mixer-settlers, which include an L-shaped baffle in the settling chamber. (Official Gazette)

ENGINEERING

Energy Conversion

Refer also to abstract 60312.

58679 (CEA-N-1542) PATIO-2: DATA ACQUISITION AND PROCESSING PROGRAM FOR THERMIONIC DIODE PARAMETERS USING A P.D.P. 8/I COMPUTER. Colomes, Jacques (Commissariat a l'Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sep 1971. 34p. (In French). Dep. NTIS (U. S. Sales Only).

A PDP 8/I computer having 8K memories is connected to a thermionic diode test bench. The computer is provided with the following peripheral equipment: a high speed perforated tape reader and punch, two teletype teleprinters, digital clocks, an A/D converter multiplexer system, a digital integration voltmeter and two magnetic tape units. The PATIO-2 program runs with the ION interrupt facility enabling the acquisition, processing, printing, and storage of the data taken from the diodes and collected by the cross-bar channels. The program differs from the PATIO-1 program (CEA-N-1347, October 1970) principally in the use of magnetic tapes for storing initial instructions as well as the processed results. Two teletype teleprinters are used: one for printing every hour the results of the diodes; the other for printing out results when required. The switch register can be used to indicate which diode has been chosen for the measurements and the form of the results; it can also be used to store the results. (auth)

58680 (UCRL-73939(Rev.2)) CORROSION AND SCALING BY STEAM IN NUCLEAR GEOTHERMAL POWER PLANTS. Krikorian, Oscar H. (California Univ., Livermore. Lawrence Livermore Lab.). 26 Jul 1972. 32p. (CONF-720607-27). Dep. NTIS.

From eighteenth annual American Nuclear Society conference; Las Vegas, NV. (18 Jun 1972).

The quality of geothermal steam produced by nuclear explosions is examined in respect to mineral content, radioactivity, and noncondensible gas content. The effects of these components on the corrosive and scaling properties of the steam are discussed. (T.F.D.)

58681 AMPLITUDE-PHASE RELATIONS FOR CURRENT AND JOULE DISSIPATION IN A DUCT WITH A CORRUGATED ELECTRODE. Levin, A. L. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 2, 185-8(1972). (In Russian).

The form of the electrode is known to affect the current distribution in a magnetogasdynamic duct. The problem of model simulation of flow in MGD ducts was considered when an irregularity occurs on the electrodes as a result of, for example, an arc discharge. Joule dissipation in the duct during a plane, steady-state flow of an electrically-conducting gas was calculated, allowing for the Hall effect but disregarding viscosity and heat conductivity of the gas. It was also assumed that the potential difference between electrodes differed little from the induced voltage due to the current in them and that it appreciably exceeded the near-electrode gradient. (K.S.W.)

58682 DIRECT ENERGY CONVERSION: PRESENT STATUS. PART 2. Euler, Karl Joachim (Technische Physik an der Gesamthochschule, Kassel, Ger.). VDI (Ver. Deut. Ing.) Z.; 114: No. 11, 784-9(Aug 1972). (In German).

The field of direct energy conversion recently has been stimulated by the common interest in environmental pollution control. A magnetohydrodynamic powerplant has been put into operation in the USSR, others will follow soon in other countries. Small nuclear reactors equipped with thermionic fuel elements now are under development in the Federal Republic of Germany. Flame-fired thermoelectric generators in the power range up to a hundred watts are manufactured in the USA. Isotopic generators will be used in marine technology, in medical electronics, and as energy sources for wrist watches. It can be predicted that portable power sources in the range of 100 watts to 10 kW will be the first commercial application of electrochemical fuel cells. (auth)

58683 SEPARATING THE LIQUID PHASE OF A MIXTURE IN A TWO-CHANNEL NOZZLE. Semenov, N. I.; Ryabov, V. A.; Polyakov, V. V. Therm. Eng. (USSR) (Engl. Transl.); 18: No. 8, 54-8(Aug 1971).

Translated from Teploenergetika; 18: No. 8, 39-41(1971).

Results of experiments on two-channel separation nozzle are presented which confirm the possibility of separating the liquid phase without great losses of kinetic energy. Separation of the liquid phase reaches 29 to 36% with nozzles of this type. Acceleration of the mixture to transonic velocities will not, apparently, greatly increase separation since the experiments confirm some tendency even to a decrease with increase in the velocity of the mixture. To obtain more effective separation it is necessary to change to multichannel nozzles and in this case it will be necessary to investigate the dependence of separation mainly on the convergence angle of the channels. (auth)

58684 ENERGY CRISIS. Crentz, W. L. J. Metals; 24: No. 5, 14-16(May 1972).

The status of energy production and consumption in the US at present is reviewed. An evaluation is presented of production capacity as related to consumption, for nuclear power, hydroelectric power, and power from fossil fuels. It is noted that a serious national energy problem exists. (J.R.D.)

58685 ENERGY IN THE WORLD ECONOMY. A Statistical Review of Trends in Output, Trade, and Consumption Since 1925. Darmstadter, Joel; Teitelbaum, Perry D.; Polach, Jaroslav G. Baltimore; Johns Hopkins Press (1971). 885p. $22.50.

The quantitative aspects of long-term trends in energy consumption, production, and foreign trade are discussed along with the transformation, during this century, of the world's fuel base away from coal and toward oil and natural gas. The presentation is divided into five parts. Part One describes and interprets the significant statistical findings. Part Two presents a series of statistical profiles, each dealing with some unique facet of the overall picture. These profiles are derived from the detailed statistics in Part Three. Part Four deals with questions of methodology and definition connected with the detailed statistical series, and also provides country-by-country source notes. Part Five presents selected supplementary materials: on energy and gross national product, matrix tables of international energy flows, and a brief bibliography. (P.C.H.)

58686 GEOTHERMAL ENERGY: AN EMERGING MAJOR RESOURCE. Hammond, Allen L. Science; 177: No. 4053, 978-80(15 Sep 1972).

The potential for using geothermal resources, particularly US geothermal resources of hot rock, hot water, or steam, for producing electricity is discussed and compared with experience in electric power generation using geothermal energy in other countries such as Italy, Japan, Mexico, and New Zealand. It is concluded that, if considerable effort and money were spent for exploration and technological development, 100,000 MW of generating capacity could be developed by the end of this century using US geothermal energy resources. (L.C.L.)

58687 THERMOELECTRIC RADIONUCLIDE GENERATOR FOR MARINE ENGINEERING. Renner, T.; Winkler, J. (Siemens AG, Erlangen, Ger.). Meerestechnik; 3: No. 2, 59-62(1972). (In German).

There is an increasing demand for long-life energy sources independent of environment to provide power for fixed buoys and beacons used in marine research and marine technology. A thermoelectric radioisotope generator (sintered ^{90}SrTiO$_3$) for terrestrial use (Tristan) has been developed by a consortium consisting of Messerschmitt-Boelkow-Blohm GmbH and Siemens AG, which is very suitable for this purpose. It is to be employed in ocean depths up to at least 3000 m. Through the realization of advanced techniques, the generator achieves an operational efficiency of 7.5%. A working model is described that has an output level of 22 W and has been under test since June 1971. (GF)

58688 THERMOELECTRIC GENERATOR. Cathey, Le Conte (to United States Atomic Energy Commission). U. S. Patent 3,677,825. 18 Jul 1972. Filed 30 Oct 1968.

A thermoelectric generator having an integral radioisotope heat source-thermoelectric converter element is described. The heat source is disposed in intimate contact between thermoelectric converter legs and is fabricated from a compound that on radioactive decay is converted to the same compound as the thermoelectric converter material. A suitable heat source material is ^{210}Po, in the form of PoTe, that converts on decay to ^{210}Pb, in the form of PbTe, so that the thermoelectric converter legs are fabricated from compatible PbTe. The latter compound is suitably doped to provide the desired semiconductor characteristics. (Official Gazette)

58689 SOLAR ERA. PART 2. POWER PRODUCTION WITH SMALL SOLAR ENGINES. Daniels, Farrington (Univ. of Wisconsin, Madison). Mech. Eng.; 94: No. 9, 16-19(Sep 1972).

The feasibility and economic aspects of producing power from small solar engines of $\frac{1}{5}$ kW capacity are discussed. Since small engines and generators are inefficient and costly, a scheme is proposed in which each engine would lift water from a lower reservoir to a higher reservoir from which it would run back and operate a large water turbine and electric generator. Another possibility is presented in which heat is stored in underground insulated pebble or gravel beds. Heat pipes would transfer the heat to operate a high-temperature vapor turbine for large-scale power production. (T.E.D.)

58690 ENGINEERING ASPECTS OF MAGNETOHYDRODYNAMICS. 11th Symposium Held at Pasadena, California, March 24–26, 1970. Elliott, D. G. (ed.). University, Miss.; University of Mississippi (1970). 220p. $10.00. (CONF-700346).

Separate abstracts are presented for 39 of the included papers. (M.O.W.)

For abstracts of individual papers see: 58691–58723, 60311–60315, and 60344.

58691 DEVELOPMENTAL PROBLEMS ASSOCIATED WITH A 20-MW HALL GENERATOR. Wright, L. E. (ARO, Inc., Arnold Air Force Station, Tenn.). pp 1-2 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

The developmental problems encountered during shakedown and operation of a 20-MW Hall generator are discussed. The problems included are those of a purely design nature as well as those associated with operational techniques. The troublesome problem areas and the eventual solutions are described in a rather detailed manner. (auth)

58692 COMPARISON OF EXPERIMENTAL AND ANALYTICAL RESULTS FOR A 20 MW COMBUSTION-DRIVEN HALL CONFIGURATION MHD GENERATOR. Sonju, O. K.; Teno, J.; Brogan, T. R. (Avco Everett Research Lab., Everett, Mass.). pp 5-10 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

The results of a continuing effort to upgrade "design" and "off design" analytical techniques for MHD generators are reported. The analytical techniques are applicable to all types of generators, but the work reported here is primarily concerned with the analysis of Hall MHD generators. The analysis is applied to the 20-MW Hall generator facility. The analytical techniques used in the analysis, including boundary layer analysis, gas nonuniformity considerations, and electrode drop effects, are reviewed. Comparisons between predicted and observed operating characteristics of the 20-MW Hall generator are discussed. Although some small discrepancies still exist, the correlation between predicted and observed performance is very good. The analysis is shown to predict the maximum loading (stalling point) of Hall generators accurately. Based on the conclusion that the analysis is quite accurate in view of the comparisons and checks made, it is felt that these analytical techniques can be used with some confidence to design and predict the performance of future MHD generators of this type with a high degree of accuracy. (auth)

58693 RESULTS OF ELECTRO-PHYSICAL RESEARCHES ON MODULE SECTION OF MAGNETOHYDRODYNAMIC GENERATOR ENIN-2. Zhimerin, D. G.; Bashilov, V. A.; Motulevitch, V. P. (Power Inst., Moscow). pp 11 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

The equipment and methods used to determine the performance of a modular section of the Russian ENIN-2 MHD generator are briefly described. The following conditions were investigated and the results reported: insulation and electrode erosion; static pressure distribution along the channel; heat flow across the module section; electric characteristics of the section; plasma conductivity; and instabilities in generator output parameters. (L.C.L.)

58694 3 MW CHANNEL FOR MHD OPEN CYCLE GENERATION WITH VARIABLE SECTION. Brzozowski, W. (Inst. for Nuclear Research, Swierk, Poland); Yerouchalmi, D.; Blattmann, H.; Skibichi, T. pp 12-15 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

A channel having a variable section has been designed for the Franco-Polish installation at Swierk (Poland). Its purpose is to study generation of electricity in subsonic and supersonic conditions. Means have been provided for measuring electric potential, gas velocities, gas and walls temperatures. The temperature of the hot ceramic wall for both electrodes and insulators is controlled. Lately, improvements have been achieved in reducing corrosion due to seed migration by using new method of assembling ceramic materials. A description of different components is given as well as theoretical considerations for the design. (auth)

58695 PERFORMANCE OF A FAMILY OF DIAGONAL CONDUCTING WALL MHD OPEN CYCLE GENERATORS. Dicks, J. B.; Wu, Y. C. L.; Crawford, L. W.; (and others) (Univ. of Tennessee Space Inst., Tullahoma). pp 16-28 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Experimental and theoretical studies have been made of the performance of a 45° diagonal conducting wall generator and a Hall generator of the same physical dimensions. The wall temperature effect is investigated and an arc model is proposed. Aluminum was successfully burned in the combustor. It was found that the coating from burning of aluminum improves the channel performance due to the heating up of the walls. It was found that the fluctuations present in the Hall channel have much higher frequencies than those in the 45° DCW channel. The fluctuations grow along the channel in the Hall mode. The presence of the aluminum attenuates the fluctuations. The effect of the low conductivity nonuniformities in the plasma and the coating of the wall has a very profound effect on the performance of the Hall generator. (auth)

58696 PERFORMANCE OF AN MHD GENERATOR CHANNEL. Ogiwara, H.; Kato, M.; Mawatari, K.; Tamaoki, T. (Tokyo Shibaura Electric Co., Ltd.). pp 29-34 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Generalized representations of the performances of an MHD generator channel are developed, using the generalized Ohm's law, in which the factors affecting the generating characteristics are treated as the two global coefficients which limit the output voltage and current. The F-value coefficients and a new loading factor K′ are defined. The degradation of the generating characteristics can be explained with these coefficients. The examples of the application of the representations are also discussed, in which the methods for improvement of the generating characteristics are described and, as a result, reduction in the F-value is theoretically derived for the channel with the pin electrodes shorting the boundary layer resistances. A nearly ideal F-value of the MHD channel was obtained in the MHD generation experiment with the pin electrodes. (auth)

58697 ELECTRODE SIZE EFFECTS IN COMBUSTION-DRIVEN MHD GENERATORS. Rubin, E. S.; Eustis, R. H. (Stanford Univ., Calif.). pp 35-40 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Three experiments were performed using the Stanford University MHD facility to investigate the effects of electrode size on the performance of a combustion-driven MHD generator. The experimental data were compared with results from an analytical model of the boundary layer. The following conclusions were drawn: for the segmented-Faraday mode of a combustion-driven MHD generator, the influence of electrode size on generator performance exists which is manifested by lower voltage losses at a larger electrode for similar conditions of surface and gas boundary layer temperature; decreasing electrode temperature worsens electrode performance, but a larger electrode size continues to have lower losses for a given temperature of the gas boundary layer; for dissimilar boundary layer temperatures, a marked change may occur in the relative performance of different electrode sizes at the same surface temperature; in the present experiments, simulation of the coupling which may exist between electrode and boundary layer temperatures in a cold-electrode generator yielded voltage losses which were greater for a large electrode with a cold upstream wall than for a small electrode with a hot upstream wall; voltage losses at a sufficiently hot anode reflect an essentially gasdynamic dependence on electrode size and temperature, and are reasonably well predicted by a two-dimensional analytical model incorporating a variable electrical conductivity in the boundary layers; in most instances, cathode drops typically reflect surface-sheath losses in addition to gasdynamic losses. These losses decrease with increasing electrode temperature and vary nonlinearly with current; and operation of electrodes below about 700 to 800°K in potassium-seeded combustion gases causes large increases in anode voltage drops. This is believed due to deposition of a resistive solid deposit on the electrode surface. (auth)

58698 ADVANCED PEAKING POWER PLANTS. Rosa, R.; Hals, F.; Teno, J.; (and others) (Avco Everett Research Lab., Everett, Mass.). pp 41-4 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

The use of simple fuel-LOX-consuming MHD plants for emergency and peaking service has been proposed and discussed. These plants have low capital cost, extremely rapid start-up capability and can be designed within the existing MHD art. More advanced plant designs are described and the pollution control aspects of such plants are discussed. The importance of these plants as a step towards the realization of base-load MHD installations is briefly considered. (auth)

58699 CONDUCTIVITY MEASUREMENTS IN PURE ARGON AT MAGNETIC FIELD STRENGTHS UP TO 2 TESLA. Hahn, G.; Salvat, M. (Institut fuer Plasmaphysik, Garching, Ger.). pp 45-8 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Results of conductivity measurements performed in pure argon at 1.1 atm pressure and 1400°K gas temperature are presented as functions of current density and magnetic field strength. The current density and the magnetic field strength were varied between 4 and 10 A/cm^2, and 0 to 2 tesla, respectively. (auth)

58700 HIGH PRESSURE POTASSIUM VAPOR DIODE STUDY. Evans, Norman A. (General Electric Space Sciences Lab., King of Prussia, Pa.). pp 49-53 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Certain applications requiring high levels of non-equilibrium magnetogasdynamic (MGD) power generation may indicate the use of condensable Rankine cycle fluids rather than the non-condensable Brayton cycle fluids, which have been extensively investigated from studies in simple diodes to experiments with actual power generation. Although the alkali metals appear to be the best candidates to use in a Rankine cycle, there is considerable uncertainty as to their non-equilibrium ionization characteristics. The study described is concerned with electrical measurements in potassium vapor, using a simple diode at pressures of the order of one atmosphere and temperatures up to 1500°K. These conditions are considered to be reasonably representative of a projected nuclear MHD system, but they result in difficulties with containment and materials compatibility necessary for the study of the vapor electrical properties. Details are given of the diode construction and sealing technique between the electrical conductor (niobium) and the insulator (Lucalox, a high purity alumina), together with initial voltage-current data up to five amps for one electrode spacing. Future changes of electrode spacing will yield information on the positive column field and the electrode losses. (auth)

58701 RESULTS OF INITIAL SUBSONIC TESTS IN THE NASA-LEWIS CLOSED LOOP MHD GENERATOR. Sovie, R. J.; Nichols, L. D. (Lewis Research Center, Cleveland). pp 82-9 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

The NASA-Lewis closed-loop MHD generator was designed to study power generation with nonequilibrium ionization using a cesium-seeded argon plasma. The results of the first five tests, in which the general design and structural integrity of the loop were studied, were reported on previously. This facility has been run subsonically seven times in the past year. These tests evaluated various loop subsystems necessary to supply the proper plasma conditions, such that the basic concepts of low-temperature (~2100°K) MHD power generation can be studied. These subsystems include an impurity purge system, a new vapor cesium injection system, a multiple electrode sidewall pre-ionizer system and various starter electrode systems. The necessity of these systems and their performance characteristics are presented. The initial generator data obtained after incorporating these components into the facility are also presented and discussed. (auth)

58702 PERFORMANCE AND DISCHARGE STRUCTURE OF A NOBLE GAS ALKALI MHD GENERATOR. Zinko, H.; Brederlow, G. (Institut fuer Plasmaphysik, Garching, Ger.). pp 90-4 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Investigations were conducted to determine whether the streamers observed in short-time noble-gas MHD generators also occur under steady conditions. The discharge structure was investigated by means of image converter pictures both in the direction of the magnetic field and perpendicular to it, in the flow direction. Information on the potential distribution in the generator was obtained from probe measurements. Furthermore, the Hall field strength and the maximum attainable power density were determined as functions of the segmentation. (auth)

58703 PERFORMANCE OF A LARGE SCALE, NON-EQUILIBRIUM MHD GENERATOR WITH RARE GASES. PART II. Zauderer, B.; Tate, E. (General Electric Co., Philadelphia). pp 95-100 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

The results of an experimental study of the operating characteristics of a large, shock tube-driven, linear MHD generator with noble gas mixtures are presented. The characteristics of the MHD facility are briefly described. The experiments were performed in a Penning mixture consisting of 99% neon and 1% xenon. The following conclusions can be drawn from this study. A significant result is that the electrical and plasma properties of this generator were about the same as in a smaller shock tube driven generator having 2% of the volume of the present generator. Thus, the present results can be reasonably expected to apply to considerably larger MHD channels. The experiments show that uniform pre-ionization, highly emitting electrodes with a long lifetime, and the absence of shock waves are the major parameters influencing the maximum attainable power output. Improving pre-ionization and electrode conduction are technological problems which should be amenable to solution. However, the elimination of shock waves and the attendant boundary layer separation as the power conversion efficiency is increased will be difficult. The present results indicate that without further increases in the magnitude of the interaction parameter, conversion efficiencies of 15 to 20% could be attained by the elimination of electrode losses. (L.C.L.)

58704 UTIAS MHD POWER GENERATION FACILITY AND RESULTS OF EARLY EXPERIMENTS. Townsend, Stanley (Univ. of Toronto). pp 101-3 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

The MHD Power Generation Facility at U.T.I.A.S. is described, and some preliminary results from several gas and MHD runs are presented. The generator is basically a blow-down plasma wind tunnel capable of simulating a portion of an eventual closed-cycle system involving a high-temperature, gas-cooled reactor. A pebble-bed graphite heater can raise argon or helium up to from 2200 to 2500°K at stagnation pressures ranging up to a limit of eight atmospheres. A 1000-m^3 vacuum sphere is connected to the downstream heat exchanger and diffuser. Thus, static pressures in the MHD duct can be varied over a range from about 10 Torr to 4×10^5 N/m^2 (4 atm.) at, say, $M = 0.8$. A large electromagnet with C-laminations provides a magnetic field of 1.7 Tesla over 15 cm × 25 cm × 125 cm (6 × 10 × 50 in.). The initial channel is a constant-area, non-cooled aluminum oxide channel. It is built up from five box sections having a 5 cm × 10 cm × 30 cm (2 × 4 × 12 in.) volume. Four sections totalling 120 cm (48 in.) lie within the magnetic field region. Fifteen cold and hot runs of air, nitrogen, argon and helium have been carried out. Boundary layer and Mach number measurements have been taken with static and total pressure probes. Nine MHD runs have been performed from February to August 1969, some with pre-ionization. Several have been partially successful, pointing to difficulties with the seeding system. The runs were done at Mach numbers up to 0.5, to up to 1780°K, mass flow rates up to 50 g/s. Currently, a new potassium boiler has been designed and the next runs are planned for April 1970. (auth)

58705 CONSTRUCTION AND TEST OF ARGAS II. Bohn, T.; Grawatsch, K.; Holzapfel, Ch.; (and others) (Kernforschungsanlage, Juelich, Ger.). pp 104-8 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

A description is given of the reconstruction of the test loop Argas required by the use of a superconducting magnet. The new experimental zone made available by this magnet is described in detail, as well as the rebuilt seed material loop. The technical experiences obtained with the reconstructed test facility until now are reported. (auth)

58706 ASPECTS OF ESSENTIAL COMPONENTS OF NUCLEAR MHD POWER PLANTS. Bohn, T.; Komarek, P.; Noack, G. (Kernforschungsanlage, Juelich, Ger.). pp 109-18 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Starting from the layout data of nuclear MHD-power plants the main components of such power plants are discussed. The question of suitable ultrahigh-temperature reactors is reviewed, considering the fast progress of developments in this field. The experiences gained during construction and operation tests of Argas II superconducting magnet are the background of the investigations on the use of large magnets for MHD-power plants. Considerations on the costs of channels and DC—AC converters resulted in the conclusion that these components are much cheaper than usually assumed. The important components, heat exchanger and turbomachines are investigated with respect to their engineering feasibility and costs. (auth)

58707 CURRENT DISTRIBUTION IN CONDUCTING WALL MHD GENERATORS. Eustis, R. H.; Cima, R. M.; Berry, K. E. (Stanford Univ., Calif.). pp 119-27 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Experiments were conducted in an MHD channel which measured the current distribution to electrodes and conducting sidewalls. It was found that anode current distributions could be predicted by a computer program with satisfactory accuracy but that cathode predictions were unsatisfactory. (auth)

58708 CURRENT DISTRIBUTION OF A SEGMENTED HALL GENERATOR. Wu, Y. C. L.; Martin, J. F. (Univ. of Tennessee Space Inst., Tullahoma). pp 128-9 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA (24 Mar 1970). See CONF-700346.

The following experiments were devised to measure the current distribution of a Hall generator. One electrode was divided into 10 segments along the magnetic field direction. The top half of the side walls of this electrode was divided into 8 segments, five of which are fine sections at the junction of the electrode and the side wall. All segments were insulated from each other with ceramic fiber paper. Each segment was connected to the bottom half of the electrode through small resistances (.10 to .20 ohm) which were used as shunts for panel mounted galvanometers. The meter panel was photographed during tests at approximated one second intervals. At short circuit conditions the total current remained relatively steady and concentrated at the two corners of the electrode with low current in the middle portion. The overall shape was somewhat symmetric about the center of the electrode. At loaded conditions the unsteady nature still remained, however, the symmetrical shape disappeared. The current concentrated only at one corner of the electrode. However, in both the short circuit and loaded case, one side wall always had higher current than the other side. (L.C.L.)

58709 AXIAL CURRENT LEAKAGE BETWEEN ELECTRODES IN MHD GENERATORS. Cutting, J. C.; Eustis, R. H. (Stanford Univ., Calif.). pp 130-4 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Experiments were conducted to investigate the phenomena of current leakage between adjacent electrodes in linear MHD generators. Measurements were made in a small scale simulated MHD generator using NaK seeded argon (T_g = 2300°K) and seeded argon with as much as 20% nitrogen additive to reduce non-thermal ionization. Data were obtained which indicate that as much as 75% of the transverse current leaks between adjacent electrodes under certain conditions. The addition of nitrogen reduced significantly the nonequilibrium effects and increased the measured Hall fields while maintaining relatively large leakage currents at transverse current densities in excess of 0.25 amp/cm^2. (auth)

58710 PULSED MHD GENERATOR ANALYSIS WITH HIGH INDUCED FIELDS. Roberts, A. S. Jr. (Old Dominion Univ., Norfolk, Va.); Palmgren, Soeren. pp 135-40 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Anticipating Faraday generator experiments utilizing a plasma burst from an exploding wire against a vacuum magnetic field, analyses were made for power and efficiency considering a resistive load. Such an MHD generator would operate briefly with a working fluid displaying larger than usual magnetic Reynolds number ($R_m > 1$) and conductively ($\sigma > 10^3\ \Omega^{-1}\ m^{-1}$). Induced B-fields and large currents complicate even our linearized, one-dimensional calculations. A time-dependent analysis is made during a generator transit time (1—5 μsec) to account for field screening and other spatial distributions, and performance results are obtained. The transient problem is approached separately to follow the effects of internal and external inductive reactances. Both models can be solved for the practically interesting case where there is little degradation of flow speed. Plasma state properties at channel entrance are taken from the few related experiments reported in the literature. (auth)

58711 TWO-PHASE NOZZLE AND HOLLOW CORE JET EXPERIMENTS. Klockgether, J.; Schwefel, H. P. (AEG-Forschungsinstitut, Berlin). pp 141-8 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

A short report is given on some experiments made with hot water flashing nozzles. Using different constraints and figures of merit, three contours were found when optimizing the nozzle geometry. These three contours are compared with each other with respect to measurements of temperature and static pressure distributions. Furthermore, some basic statements are made about the optimizing strategy called artificial evolution. The tasks allotted to and the modes of operation of a hollow jet condenser are described which serve to adapt the rapid two-phase flow emerging from the accelerating nozzles to the operational data of the liquid-metal MHD converter. Symmetry and shape of the liquid nozzle as well as the design and arrangement of the two-phase nozzles do strongly influence the formation of the condensing hollow core jet and the efficiency of the trapping funnel. The shape of the funnel significantly influences its jet entry losses. A main problem of design and operation is the prevailing pressure in the condensation chamber. Experiments carried out with both water and Freon—113 as the working media served to explain some basic problems inherent in this condensing process. (auth)

58712 LIQUID-GAS SEPARATION USING IMPINGING TWO-PHASE JETS. Bogdanoff, David (California Inst. of Tech., Pasadena). pp 149-53 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

The purpose of this investigation was to obtain a separator design with reduced friction losses for use in MHD power generator systems. The apparatus involves a pair of two-phase (water-nitrogen) convergent-divergent nozzles. The jets from the nozzle exits impinge in a channel. A capture slot may be placed on the channel center line to pick up most of the water flow, the gas being mainly diverted outside the slot. Also a louvre system may be installed extending from the outside edges of the nozzle exits to the slot. The louvres force the gas flow to turn through 150° while restraining most of the liquid flow to continue on axially towards the slot. The parameters varied were nitrogen-water flow ratio (R_F), angle between the center line of a nozzle and the center line of the complete apparatus, slot width, and slot axial position. Typical of the best separator performance obtained are flow concentration ratios of 2.6 : 1 with the fraction of the liquid flow bypassing the capture slot ranging from 0.01 to 0.05 (depending on R_F). Both theory and experiment indicate that avenues exist for considerable improvement of the impinging separator performance. (auth)

58713 PERFORMANCE OF A QUASI-ERICSSON TWO-PHASE TWO-COMPONENT LIQUID METAL MHD POWER CYCLE. Amend, W.; Hsu, C.; Petrick, M.; Roberts, J. (Argonne National Lab., Ill.). pp 154-9 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Liquid metal MHD electrical power generators possess a number of important performance characteristics which make them of potential interest for a variety of applications. The generator can be coupled to either liquid-metal or gas-cooled reactors and operated in either single-stage or multi-stage

Rankine or Brayton-type cycles with one or two component working fluids. The two-phase, two-component, quasi-Ericsson cycle employing a d-c power generator is examined in detail. The initial results of detailed cycle analysis that take into account all component losses are summarized. The expansion of the two-phase working fluid through the generator is virtually isothermal and the gaseous cycle approximates an Ericsson cycle and thus the efficiency approaches that of a Carnot cycle. The performance of this cycle has been calculated over a wide range of parameters. Detailed studies are made to establish the efficiency of the cycle and electrical characteristics of the generator. Important parameters varied are: source temperature; entrance and exit generator void fractions; cycle pressure, and number of compressor stages and intercoolings. These initial studies indicate that the proposed cycle has great potential for being developed into a high efficiency pure MHD power conversion system that could be competitive with conventional systems. (auth)

58714 PRELIMINARY EXPERIMENTAL RESULTS FROM A ONE-WAVELENGTH MHD INDUCTION GENERATOR. **Pierson, E. S. (Univ. of Illinois, Chicago). pp 161-4 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).**

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Preliminary results from an experimental one-wavelength MHD induction generator and test facility are described. The zero-field pressure gradients were up to three times the theoretical values. The measurements indicate that this is probably due to gas entrained in the liquid. The pressure gradients were reduced by adding more NaK to the storage tank. The results from 37 data points covering fluid velocities from 21.8 to 78.0 ft/sec are summarized. Only operation without compensating poles or insulating vanes is covered, including both normal excitation and excitation with the end coils shorted. Net electrical output power was obtained for these cases, but the efficiency was low. This data also supports the hypothesis of two-phase flow in the generator. (auth)

58715 NUCLEAR ELECTRIC PROPELLED SPACECRAFT USING A 300 KWe LIQUID METAL MAGNETOHYDRODYNAMIC POWER SYSTEM. **Bernero, Robert M. (General Electric Co., King of Prussia, Pa.); Jacobsen, Alan S.; Evans, Norman A. pp 165-9 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).**

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

The current status of design studies of unmanned electric-propelled spacecraft powered by a nuclear reactor with a liquid metal MHD power conversion system is reported. An initial spacecraft design is presented and described. (auth)

58716 PROGRESS REPORT ON INDUCTIVE MFD ENERGY CONVERSION RESEARCH AT DFVLR. **Peschka, W.; Carpetis, C.; Gann, A.; Henry, R. (Deutsche Forschungs-und Versuchsanstalt fuer Luft-und Raumfahrt eV, Stuttgart). pp 170-5 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).**

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

A review of work on inductive magnetofluiddynamic converter systems at DFVLR is presented in the following two-part discussion: MPD. An operational MPD-converter system has been tested with argon plasma flowing at high velocity and minimum wall contact through a channel pumped by a specially designed cryopumping system. Inductive coupling of high-frequency energy produces plasmas with high electrical conductivity for basic research studies. Velocity measurements are made by a Perot—Fabry interferometer technique, while electron density and temperature measurements are made by spectroscopic methods. Special emphasis is given to the study of gas plasma interaction with the inductive field including minimization of ohmic losses within the plasma, flow instabilities and pressure oscillations. MHD. Design of a cylindrically shaped, cryogenically cooled inductive MHD converter has been completed. Construction has been started with anticipated experimental work scheduled for the beginning of 1971. Additional features include the use of NaK as the working medium, and pure aluminum coil system cooled by liquid neon. These design features are discussed with emphasis on technological solutions and the expected behavior of the system. (auth)

58717 MHD CHANNEL FLOW AT LARGE MAGNETIC REYNOLDS NUMBERS. **Kovbasyuk, V. I.; Medin, S. A. (Inst. for High Temperatures, Moscow). pp 177-8 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).**

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

The effects of induced magnetic fields are important and should be studied together with the hydrodynamics of the flow in liquid metal or large-scale plasma MHD generators. The quasi-one dimensional approach to the induced magnetic field influence on the characteristics of the optimum flow in a linear dc MHD generator with an iron core magnet is discussed. Basic hydrodynamic flow equations were used in the conventional form neglecting friction and heat transfer losses. (K.C.K.)

58718 COMPRESSIBLE, TURBULENT BOUNDARY LAYERS WITH MHD EFFECTS, ELECTRON THERMAL NONEQUILIBRIUM, AND FINITE RATE IONIZATION. **Felderman, E. J.; High, M. D. (ARO, Inc., Arnold Air Force Station, Tenn.). pp 180-3 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).**

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

An analysis is made of the B wall boundary layer in an MHD accelerator taking into account MHD effects, electron thermal nonequilibrium, and finite rate ionization. The compressible, turbulent boundary layer equations were solved numerically for conditions typical of an MHD accelerator. Calculations were carried out using several different assumptions to calculate the electrical conductivity. Results were found to vary considerably depending upon the assumptions used; for example, the skin friction can vary by a factor of two. Calculations were carried out neglecting the Hall current, for the free-stream Hall neutralized case, and for the case of no electric field in the x-direction. (auth)

58719 HEAT TRANSFER OF PARTIALLY IONIZED NITROGEN IN CHANNEL FLOW. **Colver, G. M.; Soo, S. L. (Univ. of Illinois, Urbana). pp 184-9 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).**

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

An arc-heated channel flow system was used to determine the heat transfer parameters and transport properties of partially ionized nitrogen in laminar motion. Large deviation from equilibrium composition occurred due to large temperature gradient at the water cooled wall. With maximum gas temperature of 10^4°K, and minimum wall temperature of 500°K, significant effect of nonequilibrium was demonstrated. Results show that at the wall the conductivities of the gas were much greater than those at equilibrium composition corresponding to the gas temperature. Effect of heat released by recombination from dissociation as well as ionization in the case of nitrogen was shown. (auth)

58720 IONIZATION INSTABILITIES IN A CONTINUOUS-ELECTRODE GENERATOR. **Evans, R. M.; Louis, J. F.; Mitchner, M.; Kruger, C. H. (Stanford Univ., Calif.). pp 190-2 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).**

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Preliminary experiments to investigate the characteristics and effects of the ionization instability in a continuous electrode MHD generator are described. The current distribution on the electrodes and the transverse electric field are used to determine β_{eff}, σ_{eff}, and $\langle J \rangle$. Time correlated voltage-probe signals are used to ascertain the angle of the wave, its velocity of propagation, and its wavelength. The results are found to be in good agreement with existing data for other electrode configurations and with theory. (auth)

58721 NUMERICAL SIMULATION OF IONIZATION INSTABILITY WITH ALLOWANCE FOR DISSIPATIVE PROCESSES. **Lengyel, L. L. (Institut fuer Plasmaphysik, Garching). pp 193-8 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).**

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

A mathematical model was developed for the simulation of electrothermal waves observed in nonequilibrium MHD plasmas by formulating an initial value problem for a two-dimensional plasma bounded by rectangular boundaries. Perturbation was applied to the initially homogeneous plasma. The time development of the disturbance and the corresponding change of the average and effective plasma parameters as well as the change of the various field distributions were computed by an iterative procedure. The growth of the ionization waves is followed up in the nonlinear domain. The preliminary analysis, in which the dissipative processes were not taken into account, showed that allowance for elastic collisions alone as energy transfer mechanism affecting the electron gas is insufficient for obtaining quasi-stationary states. Realistic final ionization wave patterns can only be reached if dissipative processes are included in the mathematical description of the plasma. In the present analysis, the thermal conduction of the electron gas and the energy transfer associated with radiative processes in the plasma are taken into account. (auth)

58722 EXPERIMENTAL AND THEORETICAL STUDIES OF THE INFLUENCE OF BOUNDARY CONDITIONS ON THE DEVELOPMENT OF IONIZATION INSTABILITY. Riedmueller, W. (Institut fuer Plasmaphysik, Garching). pp 199-204 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Experimental and theoretical investigations pertaining to ionization instability in streaming plasmas in crossed electric and magnetic fields are described. The experiments were performed in a discharge parallel to the flow of an argon potassium mixture, where the gas parameters and boundary conditions were chosen so that a quasi-homogeneous and quasi-stationary state could be established. The influence of plasma boundaries and the effect of dissipation processes on the development of ionization instability have been studied theoretically. The analysis shows the existence of different modes and gives an upper limit for the number of unstable modes and for the interval of unstable wave lengths corresponding to each mode. Image converter pictures of the discharge confirm these considerations. (auth)

58723 MEASUREMENT OF THE CURRENT DIRECTIONS AND FIELD FLUCTUATIONS DUE TO IONIZATION INSTABILITIES IN A SIMULATED FARADAY-TYPE MHD GENERATOR. Burger, J.; Brederlow, G. (Institut fuer Plasmaphysik, Garching, Ger.). pp 205-8 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

The distribution of the current directions in the generator duct was determined by measuring the potential distribution. The experimental results are compared with calculated current directions. Discrepancies are explained. In addition, a double probe was used to investigate the spatial distribution of field fluctuations due to ionization instabilities. (auth)

58724 METHOD AND MEANS FOR THERMOELECTRIC GENERATION OF ELECTRICAL ENERGY. Rosso, John B. (to Combustion Engineering, Inc.). U. S. Patent 3,691,408. 12 Sep 1972. Filed 27 Jan 1970.

A system is disclosed in which gas produced from a hydrocarbon reservoir is directed through a vortex tube to separate hot and cold fractions therefrom. The fractions are passed across heat exchange elements in contact with a thermopile to produce an electric current. (Official Gazette)

58725 THERMOELECTRIC CONVERTERS AND METHOD OF MAKING SAME. Luedeman, Robert T.; Troeger, Walter Alvin (to Weston Instruments Div.). U. S. Patent 3,690,955. 12 Sep 1972. Filed 16 Jun 1969.

A thermoelectric converter employs two rods fixedly joined in juxtaposed relationship by a mounting located between different ends of the rods so that portions of both rods extend from the surface of the mounting. A coil formed with at least one, and typically a multiplicity of hot and cold thermocouple junctions is wound about rod end portions extending from the surface of the mounting, the cold junctions being in thermal contact with one of these end portions. The rods are electrically insulated from the coil and have both good thermal conductivity and rigidity. The other end portions extending from the mounting may be thermally coupled to a heat sink so that the temperatures of the cold junctions are maintained constant and low relative to their corresponding hot junctions. In addition to serving as rigid coil supports and heat sinks for the cold junctions, the rods may be laterally displaced prior to being fixedly joined by the mounting to alter the spacing between hot and cold junctions and correspondingly the converter transfer gain. Electrical access to the coil, and particularly to the coil ends, may be made by way of elongated terminal pins fixed on the mounting in a manner similar to that of the rods. Thermal isolation between pins is achievable by appropriately positioning the pins relative to the rods. Enclosure of the coil may be effected by joining a suitable housing to the mounting with a hermetic enclosure evacuated to obtain maximum level of electrical output being specifically contemplated. Also disclosed is a method of making the aforedescribed converter which includes removing discrete portions of coatings from a conductor wound on the suitably spaced rods and initially fully coated with a material of dissimilar thermoelectric properties to obtain the desired lengths of hot and cold thermocouple junctions. (Official Gazette)

58726 ALTERNATING CURRENT, SINGLE PHASE MAGNETOHYDRODYNAMIC CONDUCTION PUMP. Flores, F. (Junta de Energia Nucleare, Madrid). An. Fis.; 67: No. 7-8, 273-90 (1971). (In Spanish).

A non-compensated, ac single-phase, MHD conduction pump was designed. By using a simplified model, where the different quantities involved only vary along the pump-length, two non-dimensional numbers can be obtained, from which the length of the pump and the optimum velocity of the liquid follow. The velocity gives indirectly the transverse dimensions of the rectangular sections of the channel. (auth)

58727 NEW ENERGY SOURCES TO THE YEAR 2000. Elec. Light Power (Boston); 50: No. 17, 41-77(Sep 1972).

A special report is presented which includes articles on technological conditions in the year 2000, energy demands in the year 2000, solar power development, fusion development, development of geothermal power, development of MHD power sources, future plants and sites, environmental demands, waste heat, engineering manpower, and power transmission and distribution systems. (J.R.D.)

Facilities and Equipment

Refer also to abstract 58694.

58728 (JAERI-Memo-4024) Na MOTHER AND DAUGHTER TEST LOOP. (Japan Atomic Energy Research Inst., Tokyo). May 1970. 177p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Details of the operation of the sodium loop for the period up to December 1969, including a log of test runs No. 4 to No. 22, are presented. The test facility is located at the sodium laboratory, Tokai, Japan. The work reported is a continuation of that previously covered in the first three runs with the test loop. The individual runs differed widely in duration, ranging in length from a few weeks up to a year. Each individual test is described in terms of objectives and general outline of the test program; modifications of the loop; operating experience; various experiments carried out with the loop; and problem areas or trouble encountered during the operation. The loop system includes the mass transfer test daughter loop No. 1, the hydrogen separator daughter loop, flowmeter calibration test loop, heat transfer test loop, pump test loop, high temperature test loop and the impurity behavior test loop. The total amount of sodium has been increased from 444.4 kg to 920 kg; a new storage tank has been added to the system. Details of the daughter test loop will be reported at a later date. (TTT)

58729 (LA-DC-72-785) HYDRODYNAMIC THEORY CORRELATION FOR 72 HELIUM EVAPORATORS. Sydoriak, Stephen G. (Los Alamos Scientific Lab., N. Mex.). 1972. 10p. (CONF-720833-13). Dep. NTIS.

From thirteenth international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

Methods are described for using the hydrodynamic theory as the basis for a more elaborate correlation which fits all available data on He critical channel boiling heat flux. The theory may be used in the design of cryogenic magnets. (J.R.D.)

58730 (TID-26133) MOBILE LABORATORY MANUAL. (Oak Ridge Associated Universities, Inc., Tenn. (USA). Special Training Div.). 1971. 117p. Dep. NTIS.

The manual is for use in a course of instruction for operation of a track-type laboratory. Outlines are included on counting laboratory experiments, operation of the radiochemistry laboratory, radiation safety rules, radiation warning signs, radiochemistry laboratory experiments, supplementary experiments, radiation safety materials and study aids. (J.R.D.)

58731 COMPUTER-SUPPORTED DESIGN OF HEAT EXCHANGERS. Schnauder, H. KFK Nachr.; 4: No. 2, 14-19 (1972). (In German).

The computer program SINEX (Sodium Intermediate Heat Exchanger) was developed to compute the optimal design for sodium—sodium intermediate heat exchangers for fast breeders. The program determines not only the optimal arrangement of tube bundles but also the dimensions of significant heat exchanger components with respect to mechanical strength. Because of the relatively simple input and the easily interpretable output, the program is well suited for parameter calculations and, thus, for optimization. The output can either be printed or presented graphically. Examples of computations for various heat exchanger components are given. (H.B.G.)

58732 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGE MEANS. Linning, David Lees (to United Kingdom Atomic Energy Authority). British Patent 1,283,604. 2 Aug 1972. Filed 26 Mar 1969.

The heat exchange means described comprises a bundle of parallel elongated cylindrical members, over which fluid can be passed in heat exchange relationship. Spacing means are provided at an intermediate point along the length of the bundle for spacing the cylindrical members transversely apart, together with means composing a transverse loading on the bundle in the region of the spacing means, thus comprising a flexible skirt arranged so that fluid flow through the bundle causes fluid pressure to act on the skirt to flex it so as to impose the transverse load. The cylindrical members may be arranged in a shell, fluid being passed under pressure through the shell, and the flexible skirt being the inside wall of an annular hollow body around the inside surface of the shell. The arrangement may be described as a "tube-in-shell" type heat exchanger. A number of flexible skirts, with spacing means, may be provided at spaced intervals along the length of the cylindrical members. The spacing means may comprise a helical wrapping of wire on the cylindrical members. The arrangement may be applied to reactor fuel elements comprising bundles of fuel pins. (UK)

58733 COLLECTING SYSTEM FOR PARTICULATE MATTER. MIST SEPARATORS. Suzuki, S. (Shinwa Trading and Engineering Co. Ltd., Tokyo). Kuki Seijo; 8: No. 7, 20-3(Mar 1971). (In Japanese).

Mist separators can be installed on the upstream side of high-efficiency air filters and charcoal filters in order to protect the filters from water drops. If the performance of the mist separators is insufficient, the filters deteriorate rapidly. So it is necessary to employ the mist separators with thoroughly ascertained efficiency. The structure and efficiency of the mist separators are described as well as methods for measuring the efficiency. It is difficult to measure water drop removal efficiency for a certain water drop size. The efficiency can be ascertained in a test simulating operating conditions by knowing that the high-efficiency air filters are completely protected from sprayed water. Further, details and results of experiments performed to ascertain the efficiency are described. An experiment was carried out with a mixture of air and steam at 127°C and 2.8 kg/cm^2. In another experiment a similar spray at 104°C and 1.4 kg/cm^2 was used. In the final experiment, only steam at 127°C and 2.8 kg/cm^2 was employed. All experiments gave good results. (Japan)

58734 MIXING DEVICE FOR FINELY DIVIDED MATERIALS. Clech, Albert; Marchand, Georges; Pasouiou, Jean-Yves; Recnier, Jacques (to Commissariat a l'Energie Atomique). French Patent 2,094,283. 4 Feb 1972. Filed 16 Jun 1970. (In French).

A mixing and stirring device for finely divided fissile materials consisting of a fixed circularly symmetrical tank provided with an entrance and an exit aperture for the materials is described. A drum coaxial with the outer wall of the tank forms the inner wall of an annular space. The drum, which is rotated about its axis, is provided with a stirring arm. The drum is constructed of a neutron moderator material (polyethylene) covered with Cd (a material having a high neutron capture cross section). (auth)

58735 IMPACT ENERGY ABSORBER. Irvine, Alvin R. (to United States Atomic Energy Commission). U. S. Patent 3,675,746. 11 Jul 1972. Filed 23 Oct 1970.

This invention relates to a deformable impact energy absorber consisting of a plurality of unattached tubes confined within a larger tubulation During an impact loading the resistance to deformation increases with deformation. (Official Gazette)

Heat Transfer and Fluid Flow

Refer also to abstracts 58712, 58713, 58719, 58728, 58729, 58731, 58732, 59222, 60535, and 60539.

58736 (AERE-R-6411) POST BURNOUT HEAT TRANSFER IN HIGH PRESSURE STEAM WATER MIXTURES IN A TUBE WITH COSINE HEAT FLUX DISTRIBUTION. Keeys, R. K. F.; Ralph, J. C.; Roberts, D. N. (Atomic Energy Research Establishment, Harwell (England)). Jan 1971. 69p. Dep. NTIS (U. S. Sales Only).

Experimental results are reported on the propagation of dryout in vertical up flow of steam and water in an electrically heated tube at a pressure of 6.9×10^6 N/m^2. The 1.27 cm bore, 3.66 m long tube was machined from Nimonic 75 to withstand the high post burnout temperatures and also to provide a material with a very small change of electrical resistivity with temperature. An axi-symmetrical heat flux distribution of approximately cosine form was obtained by machining of the tube wall. Measurements were made of local wall temperature as the tube was driven into steady dryout by gradual increase of input power. At mass velocities up to approximately 2.7×10^3 Kg/s.m^2, the behavior of the system was well ordered, it being possible by small power increments (approximately 1%) to drive the steady state dryout front gradually upstream. Each power increment gave rise to a well defined wall temperature versus length locus which showed no subsequent re-wetting of the heated surface once dryout had occurred. At high mass velocity ($>2.7 \times 10^3$ Kg/s.m^2), the dryout front became very sensitive to small power changes and first dryout zones appeared suddenly but stably more than 1 m upstream of the tube outlet. Dryout zones were often short and re-wetting occurred after only a few centimetres with no apparent dryout elsewhere. In some cases, however, two simultaneous dryout zones were observed. (UK)

58737 (CEA-CONF-2033) LOCAL MEASUREMENTS IN TWO-PHASE FLOW. Delhaye, J. M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1972. 11p. (CONF-720456-1). Dep. NTIS (U. S. Sales Only).

From International conference on fluid dynamic measurements in the industrial and medical environments; Leicester, England (12 Apr 1972).

Different local quantities such as void fraction, liquid or gas velocities, and temperatures can be measured using anemometer techniques, electrical probes, microthermocouples, or optical sensors. These methods are described. (auth)

58738 (FRNC-CONF-34) CONDENSATE FLOW IN A HORIZONTAL TUBE BUNDLE. Armand, Marc; Nguyen Tho Nhan (Societe Babcock-Atlantique, Paris (France)). 1972. 7p. (In French). (CONF-720648-1). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

In the framework of studies on nuclear reactor dryer-superheaters, condensed-steam flows were studied in full-size straight-tube and U-tube bundles. (France)

58739 (NEL-217) METERING OF TWO-PHASE MIXTURES: REPORT OF A MEETING AT NEL, 6th JANUARY 1965. (National Engineering Lab., Glasgow (Scotland)). Feb 1966. 91p. Dep. NTIS (U. S. Sales Only).

A report on a meeting that was held at NEL on January 6, 1965 for the purpose of allowing an exchange of views and experience between people directly concerned with the metering of two-phase mixtures either in the operational or research field is presented. Prepared contributions received on sharp-edged orifices, nozzles, and venturi meters, gamma attenuation techniques, the use of probes, and other techniques are given in full and each discussion is grouped with its appropriate subject. (auth)

58740 (RD/B/N-2365) AN INVESTIGATION OF THE FLOW DISTURBANCE DOWNSTREAM OF RADIAL SUPPORT FEATURES IN ANNULAR DUCTS. Hall, P. C. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jul 1972. 63p. Dep. NTIS (U. S. Sales Only).

The behavior of wakes in annuli, such as could occur behind possible support features in HTR-type reactors was investigated. Measurements were made of velocity distribution, wall shear stress and pressure gradient in annuli of radius ratio 0.824 and 0.494 in the Reynolds number range from 10^4 to 10^5. The friction factors were found to be respectively 9% and 10%, greater than those encountered in a smooth pipe at the same Reynolds number. Further measurements were made, downstream, of blockages which extended radially from wall-to-wall and azimuthally through $12\frac{1}{2}$° and 24°. Pressure loss coefficients for the blockages are given. Significant azimuthal variations of wall shear stress and mean velocity were observed at up to 50 equivalent diameters downstream of the blockages. The mean perimeter was shown to be a more useful length scale than the equivalent diameter when considering azimuthal velocity variations. Flattened velocity profiles, leading to high local friction factors were found within the wakes. The flow results were used to estimate the corresponding Stanton number variations. A calculation method was devised based on the solution of a radially integrated form of the axial Reynolds equation, using a two-dimensional finite difference technique. A simple method was described for deriving values of azimuthal diffusivity of momentum, ϵ_θ, and wall shear stress from relationships found valid in two-dimensional flows. In the highly turbulent region behind the blockage, ϵ_θ was vastly greater than expected from this model. The cause of this is discussed in some detail. (auth)

58741 METHOD AND APPARATUS FOR DIMINISHING THE EFFECTS OF HEAT, FLUID FLOW, AND DRAG ON A BODY. Clark, James. British Patent 1,277,894. 14 Jun 1972. Filed 9 Jun 1969.

It is known that ionizing fluids in the vicinity of a body moving through a charged fluid can lower the heat exchange, fluid flow, and drag characteristics. A method is described to utilize these effects that involves applying to at least a portion of the body, a coating comprising a radioactive material to ionize and excite the electronic, vibrational, and rotational states of the molecules in the fluid layer immediately surrounding the body in order to reduce the viscosity and temperature of the fluid layer, and p- and n-type semiconductor materials to form a semiconductor junction biased to reduce heat flow between the fluid and the body. Heat is extracted from the fluid by conversion to electrical energy at the semiconductor junctions. (UK)

58742 MODELS OF NUCLEATION IN BOILING AND CAVITATING LIQUIDS. Bonnin, J. (Electricite de France, Paris). Bull. Dir. Etud. Rech., Ser. A; No. 1, 29-38(1972). (In French).

The initial stage of phase changes in a boiling or cavitating liquid requires the existence of nuclei about which little is known. Models providing a description of such nuclei are examined and discussed. Combined theoretical and experimenta research is expected to provide selecting effectively active models confirming the validity of investigations based on the critical behavior of the nuclei (e.g., cavitation erosion or boiling noise). (France)

58743 LIQUID SURFACE MOTION INDUCED BY ACCELERATION AND EXTERNAL PRESSURE. Moody, F. J. (General Electric Co., San Jose, Calif.); Reynolds, W. C. J. Basic Eng.; 94: No. 3, 606-12(Sep 1972).

Pressure and acceleration-induced distortion of an incompressible, inviscid liquid region is predicted numerically. The liquid is bounded by both fixed and free boundaries, and its motion is irrotational. Normal velocity is prescribed on fixed, though perhaps permeable boundaries, and the starting velocity potential is given on all free surfaces. Distortions of the liquid region are described by the motion of discrete kinematic markers assigned to each free surface. Problems are formulated on a square mesh computation field in terms of velocity potential. The liquid region interior is solved numerically by overrelaxation at every time step, which permits velocity components and potential rates to be calculated at the free surfaces. Marker positions and potentials are advanced each time step, thus preparing the computation field for further overrelaxation, and the process is repeated until finished. This technique was formulated as a Fortran IV computer program, FREESURF, for studying free surface motions. The technique can be used to solve two-dimension rectangular or axisymmetric problems with fixed boundaries and up to three free surfaces. Bubble expansion and collapse near a free surface, dam break flows, draining of a tank, and other similar problems can be predicted using the method. (auth)

58744 INFLUENCE OF CURVATURE IN POST DRY-OUT HEAT TRANSFER. Cumo, M.; Farello, G. E.; Ferrari, G. (Comitato Nazionale per l'Energia Nucleare, Casaccia, Italy). Int. J. Heat Mass Transfer; 15: No. 11, 2045-62(Nov 1972).

Post burnout heat transfer was compared in straight and coiled tubes, in order to study the influence of the geometric parameter. Freon 12 was employed, up to supercritical pressures. Two-phase flow heat transfer was better in coiled ducts than in straight ones, with higher burn-out heat fluxes, smoother and lower wall temperature rises at the dry-out point. In post burnout heat transfer a wall temperature difference between the internal and the external side of the coil (with respect to the helix axis) was set up. This temperature difference remained almost constant with quality downward from the dry-out point. It depended on flow centrifugal acceleration and pressure, and remained at moderate values up to supercritical pressures. (auth)

58745 THEORY FOR HEAT TRANSFER TO ANNULAR TWO-PHASE, TWO-COMPONENT FLOW. Pletcher, Richard H. (Iowa State Univ., Ames); McManus, H. N. Jr. Int. J. Heat Mass Transfer; 15 No. 11. 2091-6(Nov 1972).

A theory based on an axisymmetric model with no liquid entrainment was developed to allow predictions of local heat transfer coefficients. The theory treated the heat and mass transfer at the wave-roughened gas-liquid interface by using theoretical results from heat transfer to rough tubes. In comparing the heat transfer predictions with the measured coefficients, 85% of the predictions were within ±60% of recently measured values from horizontal flow. The best agreement was observed in the flow regime for which the liquid film is expected to be most nearly symmetric as was assumed in the analytical model. (auth)

58746 EFFECTS OF LIQUID MOTION INDUCED BY PHASE CHANGE AND THERMOCAPILLARITY ON THE THERMAL EQUILIBRIUM OF A VAPOUR BUBBLE. Gaddis, E. S. (Atomic Energy Establishment, Inshas, Egypt). Int. J. Heat Mass Transfer; 15: No. 11, 2241-50(Nov 1972).

A theoretical estimate is made of the liquid motion induced in the vicinity of a vapour bubble on a heated solid surface by evaporation and condensation at the bubble surface and by thermocapillarity effects. These results are used to examine the thermal equilibrium of the vapour bubble. It is found that while the effects of convection induced by evaporation and condensation are small, the effects of thermocapillarity may be important in determining the temperature of the equilibrium bubble. (auth)

58747 HEAT TRANSFER IN MAGNETOHYDRODYNAMIC COUETTE FLOW. Seshagiri Rao, S. V. (Osmania Univ., Hyderabad, India). Curr. Sci. (India); 41: No. 20, 729-31(20 Oct 1972).

Heat transfer in magnetohydrodynamic Couette flow as affected by wall electrical conductances is discussed. The flow is bounded by two moving walls which contain temperature dependent heat sources. The wall temperature is taken as constant. The exact solutions obtained indicate that an increase in the conductivity ratio at one wall gives a sharp rise in the Nusselt number at the other wall. (auth)

Materials Testing

Refer also to abstracts 58817, 59164, 59324, and 59366.

58748 (DUN-SA-191) APPLICATIONS OF ULTRASONIC HOLOGRAPHY IN THE NUCLEAR INDUSTRY. Toffer, Hans; Albrecht, R. W.; Hildebrand, B. P. (Douglas United Nuclear, Inc., Richland, Wash.). Sep 1972. Contract AT(45-1)-1857. 26p. (CONF-720903-14). Dep. NTIS.

From 20th remote systems technology conference; Idaho Falls, ID. (17 Sep 1972).

Developments in the use of sonic or ultrasonic holography in remote sensing, measuring, and information retrieval devices are reviewed. Information and discussions are included on ultrasonic holography, holography through metal slabs, specific applications of ultrasonic holography, imaging of wires, and anomalies in images. (J.R.D.)

58749 CONSIDERATIONS ABOUT THE USEFULNESS OF RADIOISOTOPIC SOURCE ^{170}Tm FOR RADIOMETRIC DEFECTOSCOPY ON THE BASE OF SPECTRAL ANALYSIS. Godlewski, Zbigniew; Brzeski, Piotr (Instytut Elektrotechniki, Warsaw). Nukleonika; 16: No. 11-12, 547-54(1971). (In Polish).

The influence of the thickness of absorber (aluminum and electrocorundum) on the energetic spectrum of a ^{170}Tm radioisotopic source was investigated. The advantages of this source for aluminum and abrasive objects radiometric defectoscopy under the condition of the work in the definite interval of the whole energetic spectrum, by the application of discrimination method, were listed. (auth)

58750 RADIOGRAPHIC TESTING METHOD. Supplement A. SNT-TC-IA 1971. Evanston, Ill.; American Society for Nondestructive Testing (1971). 44p.

Recommended practices are described for training, qualification, and certification of radiographic testing personnel whose jobs require appropriate knowledge of the technical principles underlying radiographic tests. (auth)

58751 RADIATION TECHNOLOGY: TODAY AND TOMORROW. MATERIALS TESTING AND MACHINING BY PHOTONS AND ELEMENTARY PARTICLES. Gerwin, R. Tech. Zukunft; No. 1, 75-6(1971). (In German).

Remarks on the current applications of neutrons, gamma radiation, and laser beams in materials research (e.g., materials testing, radiometric process control, holography, neutronoscopy, and ion implantation) are summarized. (INIS)

58752 ULTRASONIC TESTING METHOD. Supplement C. SNT-TC-IA 1971. Evanston, Ill.; American Society for Nondestructive Testing (1971). 39p.

Recommended practices are described for training, qualification, and certification of ultrasonic testing personnel whose jobs require appropriate knowledge of the technical principles underlying ultrasonic tests. (auth)

58753 LIQUID PENETRANT TESTING METHOD. Supplement D. SNT-TC-IA 1968. Evanston, Ill.; American Society for Nondestructive Testing (1968). 69p.

Recommended practices are described for training, qualification, and certification of liquid penetrant testing personnel whose jobs require appropriate knowledge of the technical principles underlying liquid penetrant tests. (auth)

58754 MAGNETIC PARTICLE METHOD. Supplement B. SNT-TC-IA 1971. Evanston, Ill.; American Society for Nondestructive Testing (1971). 78p.

Recommended practices are described for training, qualification, and certification of magnetic particle testing personnel whose jobs require appropriate knowledge of the technical principles underlying magnetic particle tests. (auth)

58755 EDDY CURRENT TESTING METHOD. Supplement E. SNT-TC-IA 1968. Evanston, Ill.; American Society for Nondestructive Testing (1968). 52p.

Recommended practices are described for training, qualification, and certification of eddy current testing personnel whose jobs require appropriate knowledge of the technical principles underlying the eddy current tests. (auth)

58756 RADIOGRAPHY WITH 160 MeV PROTONS. West, D.; Sherwood, A. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London); 239: No. 5368, 157-9(15 Sep 1972).

Some experimental proton radiographs are presented that show that this technique is a powerful tool that complements, and in some instances can even supplement, x-ray radiography. The 160 MeV extracted proton beam of the Harwell synchrocyclotron was employed. A feature of proton radiography is that there is no intensity change due to thickness of the object, a feature that renders the radiographs so different from those taken with x-rays or nucleons, and from autoradiographs. There is, however, a limit to the thickness of material that can be examined with a given proton energy, quite apart from the total range of the particle. Below 50 MeV the proton range limits the thickness that can be examined, and above 25 GeV the nuclear interaction length sets the limit. It is also shown that medical radiography is feasible with the Nimrod (Rutherford High Energy Laboratory) 7 GeV proton synchrotron. With a mouse, the proton radiograph showed the outline of the skin and internal membranes at the same time as the bone, which x-radiographs can only do under special circumstances. Induced activity is not a serious problem at 160 MeV, but the dose to living tissue is close to the maximum permissible level. (UK)

58757 IRRADIATION CREEP MEASUREMENT BY NEUTRON RADIOGRAPHY. Matfield, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 4, 361-5(Oct 1972).

The creep of irradiated specimens is measured by a "marker" technique whereby the change in specimen size is followed by a pair of plungers which are marked by thin washers of dysprosium. This material has a large neutron cross-section, and the marker consequently shows on a radiograph as a fine high-contrast line. The distance between two such lines is directly related to the size of the specimen, and by comparing this with the distance between two other fixed markers of known separation, also within the experiment, separation of the moving markers can be gauged precisely. This method measures the growth of the specimen to ±0.001 in. (auth)

Nuclear Explosions

Refer also to abstracts 58680 and 58789.

58758 (CEA-Bib-129(Add.1)) PEACEFUL APPLICATIONS OF NUCLEAR EXPLOSIONS: MINES, CHEMISTRY, AND GAS AND OIL EXTRACTION. Berton, Micheline (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Aug 1972. 285p. (In French and English). Dep. NTIS (U. S. Sales Only).

This bibliography is complementary to the bibliography CEA-BIB-129 written in 1968. It comprises 788 references covering principally the following domains: Nuclear Science Abstracts; Government Research Abstracts; Scientific and Technical Aerospace Reports; Bulletin Signaletique of the C.N.R.S.; Index de la Litterature Nucleaire Francaise; and Reports and books of the Central Library of Saclay. The documents are presented in a number of chapters indicated in a subject index table. Several indexes appear at the end of the bibliography: authors index, index of reports, index of review articles, index of congresses, index of books, and a patents index. (France)

58759 (NVO-746-4) PRELIMINARY SEISMICITY STUDY OF THE SOUTHERN NEVADA REGION FOR THE MONTH OF JULY 1972. Bayer, Kenneth C. (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Earth Sciences Labs.). Sep 1972. Contract AT(29-2)-746. 20p. Dep. NTIS.

A cooperative network of 21 seismic velocity-sensitive stations is operated in the southern Nevada area; the stations are monitored by the NOAA/ESL Nevada Special Projects Party located in Las Vegas, Nevada. There was no significant earthquake pattern that developed during the month of July 1972. Two seismicity maps are included; one of the southern Nevada region and the second of the seismicity on the Nevada Test Site (NTS). This is the initial monthly seismic bulletin in which the entire data analysis (including the computer programming) has been accomplished in Las Vegas by the Nevada Special Projects Party. The output is listed in the Hypocenter Summary. The listing is the result of data scaled only from the local network and solutions determined by a local epicenter program. A total of 47 epicenters is listed. (auth)

58760 (NVO-1229-170) PREDICTION OF CAVITY RADIUS AND ESTIMATION OF CAVITY GAS TEMPERATURES PRODUCED BY A CONTAINED UNDERGROUND NUCLEAR EXPLOSION. Castagnola, D. C.; Carnahan, C. L. (Teledyne Isotopes, Las Vegas, Nev.). Aug 1971. Contract AT(29-2)-1229. 55p. Dep. NTIS.

Predictions of cavity radii and cavity gas temperatures resulting from contained underground nuclear explosions in alluvium tuff, granite, salt and carbonate rocks were made. Relations are given between these cavity parameters and explosion yield, overburden density, depth of burial, geologic medium, and water content of the medium. A plot of observed values of cavity radius versus calculated values showed excellent agreement between the values for tuff and granite. However, calculated values for alluvium tend to be consistently high, possibly because of uncertainty and variations in overburden and rock densities. Cavity gas temperatures at the end of the hydrodynamic phase of an underground nuclear explosion, when it was assumed the cavity-gas pressure equalled the overburden pressure, were estimated to range from 3500 to 5000°K for alluvium, tuff, and granite; 3000 to 6000°K for salt; and 1000 to 1900°K for carbonate rock. The temperature estimates were based on numerous simplifying assumptions, equations of equilibrium thermodynamics and thermochemical data published in various sources. Published gas equations of state for several natural materials were also used. (auth)

58761 (TID-3522(Rev.9)(Suppl.1)) SELECTED, ANNOTATED BIBLIOGRAPHY OF THE CIVIL, INDUSTRIAL, AND SCIENTIFIC USES FOR NUCLEAR EXPLOSIONS. Kelly, Robert C. (comp.) (Technical Information Center (AEC), Oak Ridge, Tenn.). Jun 1972. 54p. Dep. NTIS.

This supplement to bibliography, TID-3522(9th Rev.), contains 250 annotated references to reports and published literature on the USAEC's Plowshare Program that were published in Volume 25 (1971) of Nuclear Science Abstracts. The references are arranged by subject category. Report Number and Availability, Film and Tape, Author, and Experiment Indexes are included. (auth)

58762 (TID-26171) EMPIRICAL DAMAGE PREDICTION MODEL FOR LOW-RISE BUILDINGS SUBJECTED TO GROUND MOTION. Farhoomand, Iraj; Scholl, Roger E. (Blume (John A.) and Associates, Engineers, San Francisco, Calif.). 1972. 25p. Dep. NTIS.

A statistical study was conducted using the ground motion and structure damage data from the Rulison underground nuclear gas stimulation experiment. The statistical analysis leads to identifying the ground motion characterization that best represents the damage potential of ground motion for low-rise buildings. The envelope and vector of the two horizontal components of motion were determined to correlate best with damage. An empirical model for predicting damage was developed. This model relates horizontal component envelope spectral intensity to three damage prediction parameters: number of complaints, number of buildings damaged, and damage repair cost. (auth)

58763 (UCID-30028(Rev. 1)) INPUT SOIL PROPERTIES FOR THE FINITE ELEMENT CODE "NTEDYNS." Tokarz, F. J. (California Univ., Livermore. Lawrence Radiation Lab.) 9 Mar 1972. 11p. Dep. NTIS.

NTEDYNS is a nonlinear two-dimensional dynamic finite element computer code which is being developed to solve free-field ground shock problems as the result of underground nuclear explosions. Like other computer codes used to solve free-field ground shock problems, NTEDYNS is based on a mathematically defined constitutive model. The quantitive input for such constitutive models is based primarily on laboratory test data. The most common laboratory tests employed are the "uniaxial strain test" and "triaxial shear test". Currently the constitutive model in NTEDYNS is based on stress states which are less than those required to cause soil "shear failure". The constitutive model does consider soil "tensile failure" (e.g., cracking). Free-field problems near the center of detonation, cavity collapse and stemming load problems are examples of problems which require "shear failure" type of constitutive models. Free-field problems more distant from the center of detonation and many soil-structure interaction problems can be solved using the constitutive model in NTEDYNS. The particular soil properties which are required to properly define the current constitutive relations used in NTEDYNS are indicated, and a brief outline is given of how these properties can be obtained from an "uniaxial strain test". A brief description of the "triaxial shear test" is included. (auth)

58764 SEISMOLOGICAL DETECTION AND IDENTIFICATION OF UNDERGROUND NUCLEAR EXPLOSIONS. Basham, P. W.; Whitham, K. (Dept. of Energy, Mines, and Resources, Ottawa). Can., Earth Phys. Br., Publ.; 41: No. 9, 145-82(1971).

Worldwide seismological capabilities in detecting and identifying underground nuclear explosions are assessed, based on information submitted by cooperating countries in accordance with the United Nations General Assembly Resolution 2604A(XXIV). Returns from 75 countries were received by the Secretary-General to August 15, 1970, 45 of the countries reporting information on seismograph stations are reported. The analysis attempts to answer the following question: for country A, an event is either known or reported or thought to have occurred at approximately a certain time in country B; using worldwide data guaranteed by governments, what is the possibility that country A can form an opinion as to whether the event took place, and whether it was an earthquake or an underground nuclear explosion, and how does this capability for country A deteriorate as the size of an underground explosion is reduced? A further question is: if some agency, international or national, had access to the daily abstracted seismological data that is guaranteed, to what levels of earthquake magnitude or explosion yield could an event be determined to occur, to what levels could the event be identified as either an earthquake or an explosion, and to what accuracy could it be located? A brief summary of the results and conclusions of this assessment is that the global system of stations produces proven detection, location and identification of underground nuclear explosions down to yields of about 60 kilotons in hardrock in most of the northern hemisphere: the threshold is 10 to 20 kilotons for certain test sites only, and this lower threshold cannot be reached on a global basis with this ensemble of stations. A number of recommendations are made, which, with very little financial commitment, will provide basic data required to better define existing capabilities. (Canada)

58765 HOW AND WHY TO RECORD BROAD BAND SEISMIC SIGNALS. Marshall, P. D.; Burch, R. F.; Douglas, A. (United Kingdom Atomic Energy Authority, Blacknest, Eng.). Nature (London); 239: No. 5368, 154-5(15 Sep 1972).

Most seismological observatories operate narrow band recording systems that record only that part of the seismic spectrum in which the signal/noise ratio is usually a maximum. These systems are ideal for detecting small seismic signals (say body wave magnitude, m_b, from 4.0 to 5.0) such as those generated by underground explosions of a few kt but have the disadvantage that the recorded signals are distorted versions of the true ground motion. To study seismic source functions, particularly from body waves, requires a broad band (BB) system such as the Kirnos system operated in the USSR which has a constant magnification over the range from 0.1 to 10 Hz. The drawback of such systems is that the recording band includes the strong microseismic peak at around 0.17 Hz and thus only relatively large signals, above $\sim m_b = 5.5$, are recorded. A description is given of how both broad band and narrow band recordings can be obtained from a single conventional long period seismometer. The chief cost of adding a broad band system to an established observatory is then the provision of a suitable recorder. The advantages of BB recording are demonstrated. (auth)

58766 SHORT PERIOD SEISMIC DISCRIMINATION. Manchee, E. B. (Dept. of Energy, Mines, and Resources, Ottawa). Nature (London) 239: No. 5368, 152-3(15 Sep 1972).

A method is described for utilizing the recognized differences in the short period spectra of earthquakes and underground explosions to aid in their discrimination. The method produces a dramatic increase in the separation between some Nevada Test Site explosion events and earthquakes in the Gulf of California area over that obtainable by the TMF (Time Moment of Frequency) method. (auth)

58767 OBSERVATIONS OF LONG-PERIOD (10 TO 100 SEC) SEISMIC NOISE AT SEVERAL WORLDWIDE LOCATIONS. Murphy, Andrew J.; Savino, John; Rynn, John M. W.; Choy, George L.; McCamy, Keith (Columbia Univ., Palisades, N. Y.). J. Geophys. Res.; 77: No. 26, 5042-9(10 Sep 1972).

An investigation is described of the spectral shape and the level of seismic background noise in the period range from 10 to 100 sec recorded at high-gain seismograph stations in six different regions of the world. Both vertical and horizontal power spectra were computed. These spectra are based on data recorded digitally at each site by equipment having a dynamic range of about 70 db. Each spectrum is characterized by a pronounced minimum of the noise level between 30 and 40 sec. The absolute values of this noise minimum are found to be approximately the same at these six sites, which differ greatly in both geographic location and depth of overburden. This noise minimum, or window, which appears to be worldwide in extent and extremely stable both spatially and temporally, is of great importance to the discrimination of underground explosions from earthquakes. (auth)

58768 QUASI-STATIC LOADING OF THE EARTH BY PROPAGATING AIR WAVES. Savino, John M.; Rynn, John M. W. (Columbia Univ., Palisades, N. Y.). J. Geophys. Res.; 77: No. 26, 5033-41(10 Sep 1972).

Acoustic gravity waves from an event on October 14, 1970, presumed to be a Chinese atmospheric explosion, were observed on high-gain vertical- and horizontal-component seismograms written at three different locations in the world. Reliable group velocity data for the atmosphere over propagation paths as long as 97° (10,800 km) were obtained for the period range from 30 to 375 sec. These data are in agreement with theoretical dispersion curves based on the Cospar model atmosphere with the effects of winds included. Seismic body and surface waves from this atmospheric event were also recorded at the three stations and were used to determine an epicenter. On April 14, 1971, slow-speed gravity waves from another pressure disturbance of meteorological origin were observed with periods between 240 and 360 sec on seismograms at Ogdensburg, New Jersey. The seismic recordings of the acoustic and slow-speed gravity waves are attributed to ground motion produced by surface loading and not to direct pressure effects on the instruments. The observed displacements and tilts from both events are in agreement with those predicted by static-loading theory. At the Ogdensburg station the rock layer above the instruments (543 meters) acts as a wavelength filter to suppress wind noise of short wavelength and to enhance signals from long-wavelength (coherent) disturbances in the atmosphere. (auth)

Protective Structures and Equipment

58769 PROBLEMS ASSOCIATED WITH IN-PLACE TESTING OF NUCLEAR AIR FILTERS. Suzuki, S. (Shinwa Trading and Engineering Co. Ltd., Tokyo). Kuki Seijo; 8: No. 7, 77-80 (Mar 1971). (In Japanese).

In order to reduce difficulties in finding filter leaks after in-place tests, preliminary tests of the filter casing, filter frame, and filter unit are effective. These pre-installation tests are described. First, leakage of the filter casing must be checked. Then welds in attachment faces of filters should undergo leakage tests. Smoothness of the frame should be checked in order to eliminate leakage from the contact faces of gaskets and the frames. Each filter unit is checked before installation to reduce time consuming and troublesome handling of the filters to remove and transfer from the casing when an inferior one is found at the in-place test. Precautions to be taken when installing the filters are also introduced. (Japan)

58770 MAINTENANCE OF FILTERS FOR REACTOR USE AT TSURUGA POWER STATION. Itakura, T.; Meguro, Y. (Japan Atomic Power Co., Tokyo). Kuki Seijo; 8: No. 7, 86-92(Mar 1971). (In Japanese).

The operation and performance of air filters at the Tsuruga power station are described. During emergency conditions, 10% of iodine released from fuel is assumed to be organic iodine. 86% of iodine which reaches the reactor filter system is assumed to be organic, thus collection of the organic iodine is a main problem. The collection efficiency of charcoal filters is 99.9% for inorganic iodine and 99% for the organic iodine. Therefore, the total collection efficiency for iodine, 86% of which is the organic iodine, is estimated to be 99.13%, while a 97% collection efficiency is specified for the reactor installation. Performance tests were divided into measurement of the iodine collection efficiency and measurement of iodine leakage rate. The results showed: collection efficiency for methyl iodide was 99.7%; collection efficiency for iodine was 99.9%; leakage rate for System A was 0.014%, and for System B 0.023%; estimated total removal efficiency for System A was 98.99% and for System B 98.90%. Both are above 97%. (Japan)

Safety Engineering

Refer also to abstract 58917.

ENVIRONMENTAL AND EARTH SCIENCES

58771 ACTIVITIES AND CONCENTRATIONS OF ^{18}O IN CONCENTRATED AQUEOUS SALT SOLUTIONS: ANALYTICAL AND GEOPHYSICAL IMPLICATIONS. Sofer, Z.; Gat, J. R. (Weizman Inst. of Science, Rehovot, Israel). Earth Planet. Sci. Lett.; 15: No.3, 232-8(Jul 1972).

The conventional procedure for analysis of ^{18}O in aqueous solutions yields δ ^{18}O values on an activity scale rather than a value for the isotope concentration. Conversion between the two scales in natural chloridic solutions containing magnesium calcium and potassium is given by the equation $(\delta_0 - \delta_m)/(1000 + \delta_m) \times 10^3 = 1.11\ M_{Mg} + 0.47\ M_{Ca} - 0.16\ M_K$, where δ_0 is the δ value on a concentration scale, δ_m the measured activity delta and M the molality. This linear equation holds up to molalities of 6 in pure and mixed salt solutions. The correction is of significance for a variety of geochemical processes, among them the use of the isotope content of different brines as an indicator of the salinization mechanisms of water sources. (auth)

58772 SEARCH FOR XENON ISOTOPES: FISSION PRODUCTS FROM TRANSURANIUM ELEMENTS IN NATURE. Ashkinadze, G. Sh.; Geriling, E. K.; Shukolyukov, Yu. A.; Antonov, V. I. (Inst. of Geology and Pre-Cambrian Geochronology, Leningrad). Geokhimiya; No. 7, 851-6(Jul 1972). (In Russian).

Several rocks were analyzed for their xenon content. Values from 5×10^{-10} to 2×10^{-9} cm^3/g were found and the isotopic composition of this Xe approximated that of the Xe in the atmosphere. The quantity of radiogenic Xe found was lower than that expected from a direct count of impulses from fission fragments. This discrepancy is discussed on the basis of the activation energy of release of the Xe from the mineral, and on the assumed 10% yield of Xe during the fission of a transuranium element. (K.S.W.)

Minerals and Ores

Refer also to abstracts 58783, 60611, 60612, 60617, 60637, 60638, 60667, 60685, and 60690.

58773 BEHAVIOR OF RADIOACTIVE ELEMENTS AND GOLD DURING METAMORPHISM OF THE PATOMSK HIGHLAND SEDIMENTARY ROCKS. Petrov, B. V.; Krendelev, F. P.; Bobrov, V. A.; Tsimbalist, V. G. (Inst. of Geochemistry, Novosibirsk, USSR). Geokhimiya; No. 8, 947-56(Aug 1972). (In Russian).

U, Th, K, and Au contents were studied in eight rock varieties of two sections of the Patomsk highland. The rocks have been traced in various metamorphic zones of the greenschist, epidote-amphibolite, and amphibolite metamorphism facies. A statistical reliable gold migration was established in different metapelite and aleurolite types. Gold is evacuated from rocks of the amphibolite facies and accumulates in the epidote-amphibolite or high-temperature greenschist facies. Radioactive elements are inert in the process of metamorphism. There are no correlation bonds between gold and radioactive elements. (auth)

58774 SEPARATION OF CHEMICAL ELEMENTS FROM ROCK-FORMING MINERALS AND MOUNTAIN ROCKS UNDER EFFECT OF RADIATION. Vovk, I. F. (Inst. of Geological Sciences, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 4, 305-8(Apr 1972). (In Ukrainian).

On the basis of experimental research the effect of gamma radiation was studied as applied to separation of K, Na, Ca, Mg, Fe and Si into distilled water from dispersed quartz, microcline, labradoritite, oligoclase, biotite, muscovite and ferruginated quartz sand. The separation of the elements from minerals into water in irradiated samples is 1 to 14, 1 to 8, 1 to 11, 1 to 23, 1 to 140, 1 to 247 times as high for K, Na, Ca, Mg, Fe and Si, respectively and on the average 4 to 7 times as high for the sum of K + Na + Ca + Mg as compared with control samples. Irradiation produced a 5 to 92-fold increase in iron evacuation from minerals into water during transition from the 0.25 to 0.50 mm fraction to the <0.25 mm fraction, whereas for other cations there was only a 1.5 to 2-fold increase at an average, that evidences for a great effect of active surface on physicochemical processes during irradiation. (auth)

58775 URANIUM AND THORIUM IN MAGMATIC ROCKS OF THE BUREINSK MASSIF. Putintsev, V. K.; Ditmar, G. V.; Maksimovskii, V. A.; Selivanov, V. A. (All-Union Scientific-Research Geological Inst., Leningrad). Geokhimiya; No. 7, 865-70(Jul 1972). (In Russian).

Two structural zones in the Bureinsk massif are assumed: Khingano–Yaurinck as the SE and Turansk as the NW portions, respectively. Rock samples from the Turansk contained U in a range from 1.3 to 7.9×10^{-4}%, and Th from 7 to 49.5×10^{-4}%. Rock from the Khingano–Yaurinck contained U: from 0.8 to 9.9×10^{-4}% and Th: 4.6 to 43×10^{-4}%. These values represent the ranges from over 2000 U determinations and over 600 Th determinations. The data are further discussed in terms of U and Th distribution in extrusion bodies, and the U and Th content of rock samples as functions of other oxides: SiO_2, K_2O, Na_2O, CaO. (K.S.W.)

58776 URANIUM EXPLORATION, MINING, AND MILLING. Youngberg, Elton A. (Atomic Energy Commission, Grand Junction, Colo.). pp 85-102 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

Discussion is presented on: the uranium industry, including description of bedded sandstone uranium deposits and state of the domestic industry; uranium exploration, including present technology, future technological changes, airborne prospecting, surface evaluation, and subsurface evaluation; uranium mining, including open pit mining, underground mining, and research and development possibilities; and uranium ore processing, including milling methods, other uranium recovery methods, and the need for research and development. (P.C.H.)

58777 CONVERSION AND ENRICHMENT IN THE NUCLEAR FUEL CYCLE. Levin, Robert W. (Union Carbide Corp., Paducah, Ky.). pp 103-24 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

Two of the seven fuel cycle steps are discussed: conversion of ore concentrate to UF_6 and enrichment in the ^{235}U isotope. The conversion of ore concentrate to UF_6 represents about 4% of the typical fuel cycle cost or about 0.07 mills/kwh out of a total fuel cycle cost of about 1.7 mills/kwh. (P.C.H.)

58778 SULFUR ISOTOPES AS A CLUE TO THE GENETIC GEOCHEMISTRY OF A ROLL-TYPE URANIUM DEPOSIT. Warren, C. G. (Geological Survey, Denver). Econ. Geol.; 67: No. 6, 759-67(1972).

Roll-type uranium deposits occur in sandstone beds that contain pyrite and other reduced minerals. The deposits were formed by ore-bearing solutions that contained oxygen and moved in the plane of the sandstone bed. Over a long period of time, oxygen in the ground water has destroyed most of the pyrite in an altered zone that is upstream to the present ore deposit. The sulfur was dissolved and subsequently redeposited farther downstream in the roll formation as pyrite. In the ore-forming process pyrite was continuously being destroyed in a narrow band along the edge of the altered zone and pyrite was continuously redeposited farther downstream. According to the theories developed, the following four conditions may apply to the pyrite of a roll formation: if all the dissolved sulfur takes part in the reaction that produced the pyrite in the roll formation, some of the ore-stage pyrite will be more enriched in ^{34}S than the pyrite originally present in the sandstone bed; under steady state conditions, if only part of the dissolved sulfur takes part in the reaction that produces the ore stage pyrite in a mature deposit, the proportion of ^{34}S in the roll will everywhere be lower than the pyrite originally present; if all the pyrite that is removed from the altered zone is redeposited in the roll formation, massive amounts of pyrite will be found in the deposit; and if only a fraction of the dissolved pyrite is redeposited, the total amount of pyrite in the deposit will be smaller than the total amount of pyrite removed from the altered zone. In a biogenic deposit, it is theoretically possible to redeposit all the pyrite removed from the altered tongue. The conditions for quantitative redistribution are extreme and unlikely to be attained. Although quantitative redistribution is improbable, it is discussed because the ideas contribute to theories of ore formation. If the biogenic process redistributed all the pyrite, relatively high proportions of ^{34}S should occur somewhere in the deposit, and massive amounts of pyrite should be present. If the biogenic process redistributed part of the pyrite in a steady state process, low proportions of ^{34}S should occur everywhere in the deposit, and only a modest amount of pyrite should be present. The modest accumulation of pyrite and a high proportion of ^{34}S actually in the Shirley Basin deposit seemingly exclude the possibility that biogenic processes were the principal means by which this deposit was formed. (auth)

Radioactive Effluents

Refer also to abstracts 58730, 58991, 59145, 59146, 59149, and 59369.

58779 (DOCKET-50201-132) WEST VALLEY REPROCESSING PLANT. Quarterly Report, Part I, July 1, 1972–September 30, 1972. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 10 Oct 1972. 8p. Dep. NTIS.

Environmental monitoring, radioactivity release in aqueous and gaseous effluents, and surveillance tests are reported. Gross α, gross β, tritium, ^{90}Sr, ^{129}I, ^{85}Kr, and ^{131}I releases are shown. (M.C.G.)

58780 ENVIRONMENT. Los Angeles; Southern California Edison Co. (1971). 200p.

A syllabus for use as a reference and teaching text in an environmental education program is presented. Covered are all aspects of the environment with regard to electric power generation. Five of the seven sections are abstracted separately. Two sections are not in scope for NSA. (J.M.J.)

For abstracts of individual sections see: 58792, 58793, 58827, 60592, and 60735.

58781 MONITORING OF TRITIUM DISCHARGED FROM THE FUEL REPROCESSING TEST PLANT OF JAERI. Watanabe, Kouzo; Ohnishi, Takeshi; Minami, Kentaro; Sato, Nobuyuki; Niino, Futao (Japan Atomic Energy Research Inst., Tokai). Hoken Butsuri; 6: No. 4, 183-7(Dec 1971). (In Japanese).

The fuel reprocessing test plant at JAERI was operated during the period of 1968 to 1969 to gain experience in fuel reprocessing. The fuel elements reprocessed were irradiated in the JRR-3 up to about 700 MWd/t and cooled for 87 to 300 days. Tritium is produced by fission and is one of the important nuclides to be monitored during the reprocessing of the highly irradiated fuels, because it is easily released into the off-gas line and difficult to be trapped before discharging to the atmosphere. The results of tritium monitoring at the stack are described. It was found that tritium discharged from the stack during the reprocessing was about 1% of the total inventory and its concentration in air was about 1×10^{-8} μCi/cm^3. (auth) (Japan)

58782 MONITORING OF GASEOUS ^{85}Kr RELEASED FROM THE FUEL REPROCESSING TEST PLANT OF JAERI. Sato, Nobuyuki; Ohnishi, Takeshi; Minami, Kentaro; Niino, Futao; Ohuchi, Masafusa (Japan Atomic Energy Research Inst., Tokai). Hoken Butsuri; 6: No. 4, 177-81(Dec 1971). (In Japanese).

The fuel reprocessing test plant at JAERI was operated during the period of 1968 to 1969 to gain experience in fuel reprocessing. Fuel elements reprocessed were irradiated in the JRR-3 reactor up to about 700 MWd/t and cooled for 87 to 300 days. Therefore, krypton-85 is the most dominant radionuclide in the long-lived gaseous fission products and the major part of krypton-85 in the fuel is discharged from the stack to the atmosphere in the process of uranium dissolution. The measured results of gaseous krypton-85 released in each chemical processing and the performance of krypton-85 gas monitor, in particular the relationship of counting rate and the inner pressure of the krypton-85 sampler, are described. The measured activity of krypton-85 released was in fairly good agreement with the calculated inventory. (auth) (Japan)

Radioactivity Transport and Monitoring

Refer also to abstracts 58603 and 59138.

58783 (AECL-4272, pp 33-47) ENVIRONMENTAL RESEARCH. Mawson, C. A. Sep 1972.

Progress is reported on off-site monitoring; liquid disposal area; liquid effluent monitoring; tritium survey; fate of radionuclides in aquatic ecosystems; studies on ^{60}Co and ^{90}Sr in Perch Lake Basin; St. Lawrence River studies; Perch Lake evaporation study; neutron activation analysis; atmospheric dispersion studies; environmental pollution studies; permanent storage of high-level wastes; effects of nutrient enrichment on primary production; environmental radioactivity studies; and evaporation studies. (H.L.W.)

58784 (GAT-706) PORTSMOUTH GASEOUS DIFFUSION PLANT ENVIRONMENTAL MONITORING REPORT, 1971. Emler, V. S.; Hulett, S. H.; Kalmon, B. (Goodyear Atomic Corp., Piketon, Ohio). 10 Jul 1972. Contract AT(33-2)-1. 16p. Dep. NTIS.

Established ambient environmental standards pertinent to the Portsmouth Gaseous Diffusion Plant are the radioactivity standards established by the AEC, the standards promulgated by the EPA for sulfur dioxide and particulate matter in air, and the public water-supply standards established by the Ohio Water Pollution Control Board. The ambient atmosphere and all effluent streams are monitored and analyzed regularly for conformance to the specified standards. Also, because fluorides are used in the diffusion plant and because some states have established standards for fluorides in air, the concentration of fluorides in the ambient atmosphere is measured routinely; concentration of fluorides in vegetation is measured because fluoride ingestion can cause adverse effects in livestock. None of the annual average concentrations of radioactivity measured at the many sampling points around the plant exceeded 5% of the applicable standards. Background radiation levels are the same as they were in 1954 before the plant began to operate. Average concentrations of fluorides in air, fluorides in water, fluorides in vegetation, sulfur dioxide in air, and chromium in water are not excessive; average pH of water is within the specified range. Analyses for particulate matter in air began in December; although individual analyses show concentrations in excess of the applicable annual standard, it is expected that the annual geometric mean—when sufficient data are available to permit calculation—will show compliance. (auth)

58785 (HASL-259) FALLOUT PROGRAM. **Quarterly Summary Report, June 1, 1972–September 1, 1972. Hardy, Edward P. Jr. (Health and Safety Lab. (AEC), New York). 1 Oct 1972. 309p. Dep. NTIS.**

Three papers on fallout monitoring programs reported by HASL and other agencies during the third quarter of 1972 are presented. A separate abstract was prepared for each. (L.C.L.)

For abstracts of individual papers see: 58786, 58787, and 58809.

58786 (HASL-259, pp II.1-200) HASL FALLOUT PROGRAM DATA. 1 Oct 1972.

In Fallout Program. Quarterly summary report, June 1, 1972–September 1, 1972.

Data from the HASL fallout monitoring program are presented. Information is included on ^{90}Sr content in New York City and San Francisco diets during Apr. to July 1972; Project Ainstream data from aircraft monitoring of the gamma radioactivity in the lower stratosphere along the west coast of the western hemisphere during Jan. and Mar. 1972; radiochemical analysis of air samples taken during Aug. 1970 through Mar. 1972; results of quality control studies on the accuracy of the radiochemical analyses; and the radioisotope content in the stratosphere using samples collected by balloons over the US and Australia during 1971 and 1972. (L.C.L.)

58787 (HASL-259, pp III.1-73) DATA FROM SOURCES OTHER THAN HASL. 1 Oct 1972.

In Fallout Program. Quarterly summary report, June 1, 1972–September 1, 1972.

Three fallout studies by agencies other than HASL are reported and include information on: environmental radioactivity surveys for nuclear power plants in North Taiwan; results of environmental radiation monitoring in New Zealand during 1971; and the ^{137}Cs content in human diet in Chicago during July 1972. (L.C.L.)

58788 (HASL-259(App.)) FALLOUT PROGRAM. **Quarterly Summary Report, June 1, 1972–September 1, 1972. [Hardy, Edward P. Jr.]. (Health and Safety Lab. (AEC), New York). 1 Oct 1972. 441p. Dep. NTIS.**

An appendix of tabulated data from the Health and Safety Laboratory fallout monitoring program is presented. Information is included on: the monthly deposition of ^{89}Sr and ^{90}Sr at worldwide land sites; ^{90}Sr deposition at Atlantic Ocean weather stations; radioisotopes and lead in surface air at land stations in Western Hemisphere; and ^{90}Sr content in milk and tap water in New York City for 1954 to 1972. (L.C.L.)

58789 (NERC-LV-539-2) OFF-SITE RADIOLOGICAL SAFETY FOR THE CANNIKIN EVENT, NOVEMBER 6, 1971. Fort, C. W.; Wruble, D. T. (National Environmental Research Center, Las Vegas, Nev. (USA)). Sep 1972. Contract AT(26-1)-539. 28p. Dep. NTIS.

The U. S. Environmental Protection Agency conducted an off-site radiological surveillance and public safety program in Alaska for the Cannikin Event, a high yield underground nuclear weapon test conducted on Amchitka Island on November 6, 1971. In addition to aerial and shipboard monitoring teams in the Amchitka area, personnel were stationed at twenty-five communities on Kodiak Island, the Alaska Peninsula, the Aleutian Island Chain, the Pribilof Islands, and Anchorage to monitor environmental radioactivity levels if a radioactive release occurred, and coordinate other public safety measures that might be required.

Air, water, milk, precipitation, vegetation, soil, sediment, and marine foodstuff samples were also collected during the test period. No radioactivity above usual background levels was observed, and no public safety problems were encountered. (auth)

58790 (SCPRI(RM)–7–1972 and Suppl.) REPORT OF ACTIVITY, JULY 1972. ANNEX TO MONTHLY REPORT, DETAILS OF RESULTS OF MEASUREMENT, JULY 1972. (Service Central de Protection Contre Les Rayonnements Ionisants, le Vesinet (France)). Jul 1972. 36p. (In French). Dep. NTIS (U. S. Sales Only).

The results of environmental surveys in the vicinity of nuclear installations in France are given, along with the statement of control and assistance operations in a work environment, and a monthly bibliography selection. The measurements are made monthly. (P.C.H.)

58791 SUBSTANTIATION OF THE PERMISSIBLE STANDARD VALUES OF SOLUBLE COMPOUNDS OF ^{232}Th, NATURAL THORIUM, ^{228}Ra, AND ^{228}Th IN THE AIR OF INDUSTRIAL PREMISES. Lyarskii, P. P.; Pavlovskaya, N. A.; Kapitanov, Yu. T. (Inst. of Hygiene and Occupational Disease, Moscow). Gig. Sanit.; No. 8, 53-7(Aug 1972). (In Russian).

Substantiation and verification of a number of parameters are discussed, such as the efficient energy, the efficient periods of half-removal, and the parts of radionuclides passing into the critical organs. The values received served for the calculation of the standard levels of ^{232}Th, ^{228}Th, ^{228}Ra and natural thorium in the air of industrial premises in case of work dealing with soluble noncomplex compounds of thorium. The data received prove the standard values to depend on the dispersion of aerosols and, for a mass median diameter equalling 1 mkm, for ^{232}Th they may be taken 6.7 times as high. The standards for the soluble ^{228}Ra compounds should be decreased 40 times. (auth)

58792 BROAD VIEW OF THE ENVIRONMENT. A NATIONAL CRISIS: PROGRESS, POLLUTION, AND PEOPLE. McCrackin, F. A. pp I.1-68 of Environment. Los Angeles; Southern California Edison Co. (1971).

Articles are presented on: changes for industry and Edison; intruders upon the ecosystem; wastes affecting the atmosphere—radioactive, gases, noise and vibration, chemical and heat; pollutants of water; land use and soil; and problems affecting the pollution of air, water, and soil. It was concluded that solutions to the national environmental crisis can be brought about only by a commitment of industries, state, local, and city governments, and individuals to develop and implement plans to protect the delicate ecosystem. (P.C.H.)

58793 LIFE QUALITY TOPICS. Cramer, E. N. pp VII.1-83 of Environment. Los Angeles; Southern California Edison Co. (1971).

Certain topics that have consistently appeared in customer inquiries and the news media, until they appear almost reflexive actions are discussed in the form of questions. The section is intended to be modified as new questions are identified or as new information or positions evolve. Some questions are not answered, because the information is in the relevant text section. Eventually, questions that require some choices of wording will be answered. The questions relate to aesthetics and land usage, air pollution, noise, nuclear reactors, solid waste disposal, water pollution, and general. (P.C.H.)

58794 RADIOACTIVITY AND RATE OF SEDIMENT FORMATION IN THE CASPIAN SEA. Pokidin, V. K.; Kuznetsov, Yu. V.; Prozorovich, E. A.; Asadullaeva, F. A. Geokhimiya; No. 7, 834-43(Jul 1972). (In Russian).

On the basis of data on the vertical distribution of ^{226}Ra, ^{230}Th, ^{232}Th, and ^{238}U in sediments of the Caspian Sea and with the aid of the radium-ionic method the formation rates of deep-sea and shallow water sediments have been determined, which equal respectively: 6.0 to 26.0 and 100 cm for 1000 years. The difference of vertical sections of ^{230}Th and ^{232}Th distribution in deep-sea sediments of the Caspian Sea is shown, which confirms the hypothesis about different forms of supply to these isotopes to the sea bottom. A close direct connection between the distribution of ^{230}Th and calcium carbonate in deep-sea sediments was established, which bears witness of the sorption character of the ^{230}Th withdrawal from water by chemogenic calcite. (auth)

58795 NUCLEAR ENERGY AND THE ENVIRONMENT. Bullio, Pietro. Ind. At. Spatiales; 16: No. 2, 54-8(Mar 1972). (In French).

It is necessary that a balance is found between the protection of the natural environment and progress made within the artificial environment created by man with his technology and energy sources. The construction of several thermal or nuclear plants was postponed in Italy, because of fear concerning damage to the environment, in spite of the increasing energy demands. This question is examined in different papers presented by the PIEN, ENEL, ENEA and electricity producers. (France)

58796 RADIATION HAZARD CONTROL SYSTEM. Miki, Ryota; Morishima, Hiroshige; Koga, Taeko; Uchida, Kumao; Mizumoto, Yoshihiko (Kinki Univ., Osaka). Kinki Daigaku Genshiryoku Kenkyusho Nenpo; 8: 29-37(1970). (In Japanese).

Radiation monitoring at Kinki University as of Dec. 1969 is reported. At this time, a newly constructed tracer and accelerator building was added to the areas to be monitored, and 18 persons were under control. Personnel monitoring and medical examinations indicated no abnormalities and that the maximum integrated exposure dose was 45 mR per three months. Monitoring in the controlled area, which includes measurement of radioactive surface contamination, of space dose rate, of radioactive dust and gas concentration, and the monitoring of radioactive waste, was performed. All the results are shown. Environmental monitoring included measurement of γ dose rate in atmosphere, and β activity in plants and water in surrounding areas. Nuclides of interest were ^{90}Sr, ^{137}Cs, ^{131}I, ^{106}Ru + ^{106}Rh, ^{95}Zr + ^{95}Nb and ^{60}Co. The maximum atmospheric gamma dose rate was 140 ± 46 cpm. The total β activity in plants and water is tabulated separately for every sample and point and indicates no problems. (Japan)

58797 NOTE ON THE MEASUREMENT OF RADIOACTIVE AEROSOLS. Spurny, K. R.; Lodge, J. P. Jr. (Ceskoslovenska Akademie Ved, Prague). J. Aerosol. Sci.; 3: No. 5, 407-9 (Sep 1972).

The new types of pore filter (nuclepore filters and golden membrane filters) available for measurements of aerosol concentration, aerosol particle size and particle size distribution, seem to be more convenient for practical investigations in industry and mines than the classical compact and heavy diffusion batteries. Some ways of applying these filters for the measurement and analysis of radioactive aerosols, for example in uranium mines, are discussed. (auth)

58798 COLLECTION OF AEROSOL ABSTRACTS. VOLUME I. PARTS 1 AND 2. Fuchs, N. A. (ed.). Moscow; Karpov Institute of Physical Chemistry (1971). 758p. (In several languages).

A collection is presented of approximately 13,000 abstracts of papers and books published before 1953 on experimental and theoretical studies of aerosols. The abstracts are in English or in German and are arranged in the alphabetical order of the authors' names. A subject index is included. (L.C.L.)

Atmosphere

58799 EFFECT OF CLOUDINESS AND PRECIPITATION ON THE RADIOACTIVITY OF LOWER LAYERS OF THE ATMOSPHERE. Kulagin, D. I. Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 15-17(1972). (In Russian).

Six classes of anomalous γ- and β-backgrounds were recorded in a study of cloudiness during the period of April 1966 to July 1967: weak, medium, and strong for positive and negative anomalies, respectively. "Normal" readings were made during the absence of fog, dust, storms, or precipitation. The discrepancy of the data obtained, as compared to those of previous workers, is discussed. (K.S.W.)

58800 NUMERICAL STUDY OF ^{222}Rn DAUGHTER IONS IN FAIR WEATHER AND THUNDERSTORM ENVIRONMENTS. Roffman, Amiram (New Mexico Inst. of Mining and Tech., Socorro). J. Atmos. Sci.; 29: No.4, 792-6(May 1972).

A numerical model is presented for processes that control the concentration of ^{222}Rn daughter ions in the atmosphere. Results of analysis using the model indicate that an increase in the concentration of condensation nuclei from 10^4 to 10^5 nuclei cm^{-3} causes a reduction by a factor of 7 or more in the radioactive ion concentration relative to the ambient concentration of ^{222}Rn. Electric fields such as those existing during thunderstorms are the dominant cause of the high depletion of the radioactive ions due to their migration. Electric fields with storm polarity ($E > 0$) of the order of 60 to 100 V cm^{-1} cause a reduction by a factor of 8 or more in the ion concentration relative to the ambient ^{222}Rn concentration close to the ground. The migration effect producing a decrease in the ion concentration that can be observed up to about 30 m above the ground, beyond which the concentrations approach the value of fair weather. In spite of the changes in the vertical transport due to eddy diffusion, the ion concentration relative to the ambient concentration of ^{222}Rn remains relatively constant. Recombination effect is negligible compared to attachment and migration effects. (auth)

58801 COMPARISON BETWEEN THE WEIGHTS AND THE RADIOACTIVITY OF ATMOSPHERIC DUSTS COLLECTED BY A CASCADE IMPACTOR. Renoux, A.; Tymen, G.; Madelaine, G. (Univ., Brest, France). Atmos. Environ.; 6: No. 10, 765-73(Oct 1972). (In French).

Using a cascade impactor Casella Mk2, mass distribution and radioactivity of atmospheric aerosols in low polluted sea air (dust mean weight 110 μg m^{-3}) were simultaneously studied. It was found that 20% of the full mass was distributed on particles of radii smaller than 1 μm, 50% on particles up to 2.5 μm and 70% on aerosols smaller than 4 μm. In addition to this, 20% of α radioactivity due to radon decay products was found on particles of radii higher than 0.25 μm. This result is not in accordance with the distribution law $dN/dR = CR^{-3}$. A comparison is made between α activity fixed on large aerosol particles and dust concentration in the atmosphere. (auth)

58802 APPLICABILITY TO GREENFIELD'S MODEL OF GROSS β RADIOACTIVITY DATA IN FALLOUT AND AIR COLLECTED IN ITALY. Faloci, C.; Lucci, F.; Susanna, A. (CNEN, Rome). Atmos. Environ.; 6: 69-72(1972) (RT/PROT(72)3).

A definition of the relationship between height of precipitation and gross β radioactivity in air and fallout is given. The long-range trend of the ratio between gross β radioactivity in air and fallout versus the height of precipitations, resulting from measurements carried out in Italy from 1961 to 1967 at the national networks is considered. Greenfield's model was taken into account and consistency of the data with that model was examined. The results are briefly discussed. (auth)

58803 RADON FLUX OF THE SEA. Hoang, Chi-trach (CNRS, Gif-sur-Yvette, France); Servant, Jean. Compt. Rend., Ser. D; 274: No. 24, 3157-60(12 Jun 1972). (In French).

The radon flux emitted into the atmosphere from the sea is calculated from the deficiency in radon with respect to the quantity of radium present at the surface. Values lying between 11 ± 1 and 260 ± 32 atoms m^{-2} s^{-1} were calculated for this flux. In the 55 to 65 degree latitude (south) region, which is almost entirely covered by sea, the presence of radon in the atmosphere is probably due to that released from the surface of the sea. The flux in this region is equal to 135 ± 6 atoms m^{-2} s^{-1}. (France)

Soil

58804 UNDERGROUND MIGRATION OF RADIONUCLIDES PRODUCED IN SOIL NEAR HIGH ENERGY PROTON ACCELERATORS. Borak, T. B. (National Accelerator Lab., Batavia, Ill.); Awschalom, M.; Fairman, W.; Iwami, F.; Sedlet, J. Health Phys.; 23: No. 5, 679-87(Nov 1972).

The radioactivity ($T_{1/2}$ > 15 d) induced in soil by high-energy hadrons was measured by radiochemical analysis of soil samples irradiated near two proton synchrotrons. Laboratory experiments were then performed to determine which of the radionuclides could be leached by water. Of the isotopes identified in the soil (^{3}H, ^{7}Be, ^{22}Na, ^{45}Ca, ^{46}Sc, ^{48}V, ^{51}Cr, ^{54}Mn, ^{55}Fe, ^{59}Fe, ^{60}Co) only ^{3}H, ^{22}Na, ^{45}Ca and ^{54}Mn were observed in the leach waters. Macroscopic production cross sections and ion velocities relative to ground water flow in soil near the National Accelerator Laboratory are presented. (auth)

58805 ESTIMATION OF THE INDUCED RADIOACTIVITY OF THE GROUND WATER SYSTEM IN THE NEIGHBOURHOOD OF A PROPOSED 300 GeV HIGH ENERGY ACCELERATOR SITUATED ON A CHALK SITE. Stapleton, G. B.; Thomas, R. H. (Science Research Council, Chilton, Eng.). Health Phys.; 23: No. 5, 689-99(Nov 1972).

Estimates of radionuclide production in the earth shielding and ground water around a proposed 300 GeV proton synchrotron are reported. At a particular chalk site studied ^{3}H, ^{7}Be and ^{32}P were shown to warrant detailed investigation. Chemical sorption on rock chalk eliminates ^{7}Be and ^{32}P as significant contaminants of the ground water system. In addition, the relatively short residence times of water in regions of high neutron flux density and subsequent dilution in the ground water of the particular site studied ensure that tritium contamination would be inconsequential. (auth)

58806 POSSIBLE FORMS OF RUTHENIUM MIGRATION IN SURFACE WATERS AND SOILS. Varshal, G. M.; Koshcheeva, I. Ya.; Morozova, R. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya; No. 8, 971-6(Aug 1972). (In Russian).

The interaction of ruthenium(IV) with organic matter isolated from the effluents of the Moscow River, including their main component—fulvic acids, was studied. The formation of stable anionic forms of complex compounds of ruthenium(IV) with fulvic acid was studied by means of solubility and electrophoresis. Ruthenium solubility increases in the presence of fulvic acids by 2 to 4 orders in comparison with ruthenium solubility in water in the absence of organic matter. The conventional equilibrium constant of the reaction of ruthenium interaction with fulvic acids was calculated. The relatively high capacity of ruthenium for migration in waters and soils was considered from the standpoint of its complexing with the organic matters of water. (auth)

58807 DIFFUSION OF RADON INSIDE ROCK GRAINS. Lambert, Gerard; Bristeau, Pierre; Polian, Georges (CNRS, Gif-sur-Yvette, France). Compt. Rend., Ser. D; 274: No. 25, 3333-6(19 Jun 1972). (In French).

The disappearance of a surface layer of ^{222}Rn implanted in rock samples was measured using α particle spectrometry. The comparison between the experimental results and the theoretical radioactive decay curves leads to an upper limit to the velocity with which the radon leaves the grains. (France)

Water

58808 (EUR-4865) STUDIES ON THE RADIOACTIVE CONTAMINATION OF THE SEA. Annual Report, 1971. Bernhard, M. (ed.) (Comitato Nazionale per l'Energia Nucleare, La Spezia (Italy). Laboratorio per lo Studio della Contaminazione Radioattiva del Mare). Aug 1972. 162p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 210.-.

The eight Annual Report of the CNEN—EURATOM Contract of Association is presented. The program laid down in this contract calls for studies of the factors which influence the uptake, accumulation, and loss of radioisotopes by different inorganic and organic constituents of the marine environment. The program is divided into two parts: the investigations of relevant radioecological and ecological factors in nature and under laboratory conditions; and the investigation of the outfall area off-shore of the CNEN-TRISAIA Centre in the Gulf of Taranto (fuel reprocessing plant). The task of carrying out this program has been divided between six groups: Chemistry, Botany, Zooplankton, Fisheries Biology, Microbiology and Special Developments. An account is given of the results obtained in 1971. (auth)

58809 (HASL-259, pp I.2-16) WORLDWIDE DEPOSITION OF ^{90}Sr THROUGH 1971. Volchok, H. L. 1 Oct 1972.

In Fallout Program. Quarterly summary report, June 1, 1972—September 1, 1972.

In 1971 the worldwide fallout of ^{90}Sr was 338 kilocuries and the total deposit on the surface of the earth by the end of the year had increased to 12.23 megacuries. Most of the ^{90}Sr in both hemispheres was stratospheric, evidenced by both the amount deposited and the seasonal variation. (auth)

58810 PHYSICOCHEMICAL STATES OF SOME TRACE ELEMENTS IN SEAWATER WHICH ARE OF INTEREST FROM THE RADIOCONTAMINATION STANDPOINT. Piro, A. (CNEN-EURATOM, La Spezia, Italy). Rev. Int. Oceanogr. Med.; 20: 1-17(1970). (RT/PROT(72)10).

The necessity of studying the introduction of radioisotopes in seawater and their permanence in relation to the physicochemical states of the radioisotope and the corresponding stable isotope in seawater, as well as to the physical, chemical and biological characteristics of the contaminated environment, is discussed. The concept of isotopic dilution and the concentration factor have therefore to be seen in relation to the knowledge of the above mentioned parameters because the physicochemical forms of the contaminating isotope can or cannot enter in equilibrium with the other physicochemical states already present. (auth)

58811 RADIOACTIVE SPRINGS IN TONO DISTRICT IN GIFU PREFECTURE. Mikai, Kinuko; Hayakawa, Tomokuni (Gifu Prefectural Inst. of Publich Health, Japan). Onsen Kagaku; 21: No. 3-4, 104-20(Dec 1970). (In Japanese).

The Rn content of 260 springs in Tono and the other districts in Gifu Prefecture was determined by using an IM Fontactoscope. Sixty-eight mineral springs contained more than 30 × 10^{-10} Ci/l of radon. Among them, 57 springs were found in Tono District which is predominant in granitic rocks. Uranium ore deposits are found widely in the southern part of the district. Radioactive minerals are obtained from this district. As for the radon content of the waters, Yunoshima, Kurimoto and Shonoyu springs in Tono District contained 1442 × 10^{-10}, 407 × 10^{-10} and 563 × 10^{-10} Ci/l of Rn respectively. Any distinct difference was not observed between the values formerly obtained and those obtained by the author with the exception of Shonoyu Spring. The temperature of the springs was mostly lower than 20°C except for Sogi Spring which was 29°C lower. Most of the waters were from 6.0 to 7.9 in pH-value, while the springs in the southern part of the district were high in pH-value. Sogi Spring had a 9.6 pH-value. The content of evaporated residues in the waters was lower than 1g/kg except in four springs of salt or alkaline spring type. No relationship between radon content and pH-value, evaporated residue, chloride, fluoride, and hydrogen sulfide content was found. (auth) (Japan)

Ecosystems and Food Cycles

Refer also to abstract 59134.

58812 (EUR-4858) RADIOACTIVE CONTAMINATION OF FOODSTUFFS IN THE COUNTRIES OF THE COMMUNITY IN 1970. (European Communities, Luxembourg. Commission). Jul 1972. 66p. (In several languages). Dep. NTIS (U. S. Sales Only). EUR FB 100,-.

This report contains measurement data on the radioactive contamination of foodstuffs in the Community countries in 1970. The data relate to the radionuclides ^{90}Sr and ^{137}Cs. Tables and graphs illustrate the pattern followed in the course of the year. The average milk contamination for the Community is compared with that of the United States, Canada, the United Kingdom, and Denmark. An estimate is given of the strontium-90 intake. For 1970 this intake averages 3865 pCi of strontium-90, which corresponds to 14.4 pCi/gCa in the diet. (auth)

58813 CONTAMINANTS IN ANIMAL PRODUCTS. I. MATHEMATICAL FORMULATION OF RADIONUCLIDE METABOLISM AND THE SIGNIFICANCE OF CONCENTRATION FACTORS IN THE COMPUTATION OF PERMISSIBLE CONCENTRATIONS OF CONTAMINANTS IN FEEDSTUFFS AND FOOD PRODUCTS. Dreusicke, M. Arch. Tierernaehr.; 20: No. 6, 497-508(1970). (In German).

The derivation and use of concentration factors for the calculation of the maximum permissible levels of radionuclides in components of animal diets are described. The factors are derived by multiplication with the maximum permissible levels in animal products intended for human consumption. Compilation of similar lists of concentration factors for nonradioactive contaminants is suggested. (EURATOM)

58814 INVESTIGATIONS OF THE NATURAL RADIOACTIVITY OF THE RADIOISOTOPES CONTAINED IN GRAPE ASH. Davidescu, D.; Davidescu, V.; Stanef, I.; Raducanu, E. Rev. Hort. Viticult.; 19: No. 11, 56-63(1970). (In Rumanian).

The natural activity of the radioisotopes was studied in the must ash, husks, and stones of Regina Viilor grapes. This research was carried out in six vineyards. Natural radioactivity was measured on a low-base NE-8102 counter made in England. The spectral analyses of ashes proved that at the time when the specimens were collected (the period of commercial consumption maturity), natural radioactivity was different. It was higher in the must from Bucharest and T. Severin. The husk radioactivity was more significant in the specimens from Murfatlar and Bucharest. The grape stones from Murfatlar and T. Severin were the most radioactive. A lower radioactivity was recorded in the must specimens from Greaca and Drăgăşani, in the husks from Valea Călugărească and in the grape stones of Greaca. (auth) (EURATOM)

58815 RADIOECOLOGICAL INVESTIGATIONS IN A THERMAL SPRING REGION. Lovric, G. (Univ. of Zagreb); Strohal, P. Limnol. Oceanogr.; 17: No. 3, 441-4(May 1972).

Radioactivity of the thermal springs at Tuheljske toplice in northwestern Yugoslavia was studied. Naturally occurring radioactivity due to ^{234}Pa, ^{226}Ra, ^{222}Rn, ^{214}Pb, and ^{214}Bi was detected. Radioactivity was measured in thermal spring water and sediments, as well as in the biota of this region. The level of radioactivity measured suggests the possibility of investigating the influence of small doses of radiation on biocenoses, since such conditions have existed for centuries. (auth)

58816 EFFECT OF FOODSTUFFS AND RELATED COMPOUNDS ON DURABILITY OF GLAZES CONTAINING NATURAL THORIUM, AND NATURAL OR DEPLETED URANIUM. Stradling, G. N.; Green, N.; Fletcher, M. A. (Queen Elizabeth Hospital, Birmingham, Eng.). Trans. J. Brit. Ceram. Soc.; 71: No. 6, 171-5(Sep 1972).

Glazes liable to contain up to 10% natural thorium and natural or depleted uranium as their mixed oxides, primarily intended for commercial application to tableware etc., were examined. The unique colors obtained could have widespread application in the ceramics industry, and the potential hazards associated with the use of such materials are radiological in addition to chemical. Since no detailed assessment exists of the potential radiological hazards from the use of such glazes, and the standards applied by the industry appear to be based on extremely limited evidence, their durability following prolonged contact with a wide variety of foodstuffs, related compounds and chelating agents was investigated to determine the potential internal hazards, and radiation monitoring film was employed to evaluate the potential external irradiation hazard. The results obtained, when compared to the most stringent requirements presently applied by the industry for toxic elements, and the current recommendations of the International Commission on Radiological Protection, indicate that the potential hazards to users of the glazes described would be negligible and confirm the anticipated durability of glazes with a high alumina and silica content. (auth)

Radiometric Techniques

58817 NUCLEAR RADIATION EXPOSES ART FORGERS AND COIN COUNTERFEITERS. Kowalski, Heinrich (Commission of the European Communities, Brussels). Euro- Spectra; 11: No. 2, 47-55(Jun 1972).

Methods of testing coins and art objects for authenticity are described. Discussions are included on use of radiation in structural investigations, the use of radioactive decay in age estimations of oil paintings, x ray fluorescence and activation analysis, coin analysis, and analytical techniques. (J.R.D.)

58818 THERMOLUMINESCENCE DATING AND THE SENSITIZATION METHOD. Adam, G. (Israel Atomic Energy Commission, Beersheba). Health Phys.; 23: No. 4, 579-80 (Oct 1972).

A sensitization correction is suggested for the determination of the total accumulated dose when dating pottery by the thermoluminescence method. It is pointed out that quartz exhibits a variation in sensitivity with exposure dose. For samples in the range of 2000 y, the total dose is ~500 R. The increase in sensitivity of the 100°C thermoluminescence peak is by a factor of 8 to 40, depending on the heat treatment of the quartz. (UK)

58819 DIGITAL RECORDING OF MASS SPECTRA IN GEOLOGIC STUDIES. II. Stacey, J. S.; Wilson, E. E.; Terrazas, R. (Geological Survey, Denver). Can. J. Earth Sci.; 9: No. 7, 824-34(Jul 1972).

The digital system described can record data from several mass spectrometers on a single magnetic tape. Programs were written for isotopic abundance calculations of lead, thorium, uranium, strontium, and argon analyses. The programming techniques successfully recognize and reject spurious data. Both chart and digitally recorded data are presented for seven analyses of the U.S. National Bureau of Standards common lead standard SRM 981. Standard deviations of the ratios of the digital data range from 0.018% for the ^{207}Pb/^{206}Pb to 0.038% for the ^{208}Pb/^{204}Pb. The equivalent hand-processed values are 0.044 and 0.066%, respectively. The measured ratios are offset from their absolute values almost entirely by a fractionation component of about 0.16% per mass unit. Other bias introduced by the system is shown to be very small and probably not greater than 0.01% for the digital data and 0.05% for chart-read data. Calibration of the vibrating reed electrometer amplifier with current flowing through the feedback resistor has considerably improved the analytical precision and reduced the system bias. (auth) (Canada)

58820 IN-SITU ASSAYING FOR URANIUM IN ROCK FORMATIONS. Givens, Wyatt W.; Caldwell, Richard L.; Mills, William R. Jr. (to Mobil Oil Corp.). U. S. Patent 3,686,503. 22 Aug 1972. Filed 18 May 1970.

A specification disclosing a technique for assaying for delayed fission neutrons from uranium to obtain a quantitative measure of uranium ore grade is described. A pulsed neutron source of 14-MeV neutrons and a neutron detector are located in a borehole at the level of a formation of interest. The source is operated cyclically to irradiate the formations with bursts of fast neutrons, and the resulting neutrons from the formations are detected. Measurements are made of those neutrons detected between neutron bursts and indicative of delayed neutrons emitted as a result of neutron fission of uranium. Measurements also are obtained in a nonore-bearing formation to record the count of delayed neutrons emitted from oxygen when irradiated. These measurements are compared with those obtained in the ore-bearing formations of interest to correct for the effect of the oxygen background. (Official Gazette)

58821 SIMULTANEOUS PULSED NEUTRON WELL LOGGING. Hopkinson, Eric C.; Youmans, Arthur H. (to Dresser Industries, Inc.). U. S. Patent 3,691,378. 12 Sep 1972. Filed 26 Jun 1970.

Methods and apparatus are disclosed for obtaining simultaneously a well log of the macroscopic thermal neutron cross-section (Neutron Lifetime Log) of formations adjacent a well bore and logs of the capture gamma rays, epithermal neutrons, and thermal neutrons returning to a well bore as a result of irradiating the formations adjacent the well bore with pulses of neutrons. The thermal and epithermal neutron logs are obtained by separating the signal from a single detector into two time-dependent groups. Methods and means are also disclosed for combining the capture gamma ray log with the thermal neutron log to obtain a log indicating the salinity of the fluids contained in the formations. Methods and means are also disclosed for combining the epithermal neutron log with the thermal neutron log to obtain a log related to the macroscopic thermal neutron cross-section of the formations. Either or both of these derived logs may be obtained simultaneously with the first suite of logs. The preferred embodiment of the apparatus disclosed includes a pulsed source of 14-MeV neutrons, a gamma ray detector, and a neutron detector sensitive to both thermal and epithermal neutrons in the subsurface instrument. Surface apparatus includes the appropriate gating circuits and ancillary circuits whereby the gamma rays detected while the neutron source is quiescent are used to form three signals corresponding to the gamma rays detected in three time periods. Similarly, the surface apparatus includes gating and ancillary circuits to separate the detected neutrons into two time groups. (Official Gazette)

58822 STUDY OF FUEL SHALES IN THE BALTIC BASIN BY THE GAMMA–GAMMA LOGGING METHOD USING SINGLE-STAGE SCATTERED RADIATION. Makarov, A. N.; Loginov, M. I. Vestn. Leningrad Univ., No. 6, Geol., Geogr.; No. 1, 154-6(Mar 1972). (In Russian).

Modification of gamma-gamma well-logs for once-scattered radiation from a small energy source was used to study thin-layered heterogeneous cross-sections of industrial-grade oil shales in the Baltic basin. A microsonde of 5 cm size with a collimated source and detector was used for the purpose. This modification for such a small probe has a higher sensitivity than others. Layers of oil shales are marked by intensive relative anomalies (up to 8.5). Thin layers of oil shales (3 to 5 cm) and seams and concretions of carbon-bearing rocks may be precisely outlined. The thickness of the layers and seams may be determined with accuracy up to ±2 cm. (auth)

58823 COMPARISON BETWEEN RADIOMETRIC AND FISSION TRACK AGES OF MICAS. Bigazzi, G.; Cattani, M.; Cordani, U. G.; Kawashita, K. (Univ., Pisa, Italy). An. Acad. Brasil. Cienc.; 43: No. 3-4, 633-8(1971).

The density of tracks from spontaneous fissioning uranium atoms in mica was used to make quantitative measurements of geologic ages. It was observed that this dating method can be used provided that no annealing of tracks or diffusion of uranium has occurred. This method is much simpler than the usual radiometric methods and seems to be accurate for micas up to a few hundred million years old. Track-annealing experiments suggest that high ambient temperatures are responsible for the eventual disagreement between the radiometric and the fission track ages. The apparent ages of 17 micas determined by K–Ar, Rb–Sr, and fission track methods are compared. Five of these micas are older than 1 billion years. It was concluded that, in general, the fission track ages agree with the radiometric ages up to 1 billion years. (L.C.L.)

58824 IMPROVEMENTS IN AND RELATING TO BOREHOLE LOGGING TECHNIQUES. Moore, Donald C.; Tittmann, Jay (to Schlumberger Inland Services Inc.). British Patent 1,282,937. 26 Jul 1972. Filed 5 Aug 1969.

The apparatus incorporates a γ-ray source for the irradiation of strata together with one or more detectors and associated electronic equipment. The electronic equipment produces characteristic signals in response to γ rays detected in the energy range either below or above the K absorption limit for barium. By comparison of these signals the effect of barium can be determined. The energy ranges are normally 24 to 33 keV and 39 to 41 keV. In addition, the output of two further detectors, one sensitive to soft γ-rays (39 to 120 keV) and the other to hard γ-ray (240 to 300 keV), may be compared. Details are given of the use of the apparatus for determination of the earth formation in a borehole. (UK)

Site Surveys

Refer also to abstract 58805.

58825 (KFK–1606) STATISTICAL EVALUATION OF WIND MEASUREMENTS IN THE KARLSRUHE NUCLEAR RESEARCH CENTER FOR THE YEARS, 1968–69. Nester, K. (Kernforschungszentrum, Karlsruhe (West Germany)). Jun 1972. 41p. (In German). Dep. NTIS (U. S. Sales Only).

The wind measurements performed in 1968 and 1969 at the 200 m meteorological tower of the Karlsruhe Nuclear Research Center are evaluated statistically. The frequency distributions of the wind direction and wind speed as well as the average daily variations of the wind direction and the wind direction shear present a survey of the wind situations in the environment of the research center. In order to estimate long-term concentrations, statistics of the relevant diffusion parameters are evaluated. The diffusion categories are determined on the basis of the wind profile measured. This evaluation is completed by the average daily variation of the diffusion categories. (auth)

Thermal Effluents

Refer also to abstracts 58792, 60637, 60638, 60667, 60700, and 60733.

58826 (NYO–4260(Pt.3)) USE OF THE CHESAPEAKE BAY FOR COOLING THERMAL-ELECTRIC POWER PLANTS. PART III. RESEARCH AGENCIES AND INSTITUTIONS WORKING ON CHESAPEAKE BAY. Meyers, Caldwell D.; Peregoy, Margareta A.; Borenstein, Richard A. (comps.) (Johns Hopkins Univ., Baltimore, Md. (USA). Dept. of Geography and Environmental Engineering). May 1972. Contract AT(11-1)-3291. 68p. Dep. NTIS.

A list is presented of organizations conducting research concerned with the Chesapeake Bay or which have plans to initiate such studies within the next six months. This directory is intended to provide individuals interested in the Bay with insight into what others are doing in this research area for coordination purposes. (J.R.D.)

58827 WATER QUALITY. Slagle, K. A. pp III.1-27 of Environment. Los Angeles; Southern California Edison Co. (1971).

The need for water in generating electricity and the environmental effects associated with power generation uses of water are discussed. (P.C.H.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 58917.

General Detectors and Monitors

Refer also to abstracts 58959, 58991, 59375, 59394, and 60385.

58828 (AECL–4157) MONITOR FOR MEASURING BETA CONTAMINATION ON THE FLOOR. Jones, A. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jun 1972. 9p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

The monitor detects β contamination on the floor above the level of 0.1 nCi/cm^2 when spread over an area of 645 cm^2, or more. It measures contamination levels in the range 0.1 to 10 nCi/cm^2 and the result is displayed on a 2-decade logarithmic scale. For the two jobs, detection and measurement, two response times are available by switching, each giving constant statistical accuracy (standard deviations of 10 and 3% respectively). Gamma background compensation functions properly in fields up to 9 mR/h. The detectors are five rugged side-window Geiger counters which are shock mounted. The design and performance of the monitor is described and three appendices give operating instructions, the adjustment procedure and typical circuit voltages. (auth)

58829 (AECL–4272, pp 49-65) HEALTH PHYSICS. Cowper, G. Sep 1972.

Topics include spark counting technique for damage track dosimeter measurements, modifications of the fission spectrum by thin moderators, thermoluminescence dosimetry, semiconductor detectors, tritium-in-air and tritium-in-water monitoring, energy loss studies, detection of iodine in air, methods of sampling for ^{125}I, microscopic flying-spot scanner, specimen preparation for heavy atom imaging by electron microscopy, calculator programs, and routine dose monitoring. Publications and lectures are listed. (W.H.K.)

58830 (COO–1105-180) SIMPLE PHYSIOLOGICAL AND STATISTICAL MODEL FOR PERCEPTION OF OBJECTS IN A NOISY IMAGE. Moran, P. R. (Wisconsin Univ., Madison. Dept. of Physics). 1972. 4p. (CONF-720835–1). Dep. NTIS.

From third international conference on medical physics; Goteborg, Sweden (Aug 1972).

The model is presented for interpretation of photographs and TV displays of in vivo radioisotope distributions. (W.H.K.)

58831 (GERHTR–8) APPARATUS FOR MEASURING THE RELEASE OF FISSION GASES AND OTHER FISSION PRODUCTS BY DEGASSING. Stradal, Karl Alfred (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Translation of report JUL–707-RW. 69p. Dep. NTIS.

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

Work performed under United States–German High Temperature Reactor Research Exchange Program.

An apparatus which was developed and installed in order to measure to a higher degree of sensitivity and in serial measurements the release of fission gases and volatile fission products is described. (auth)

58832 (RFP–1807) SINGLE-RANGE ALPHA COUNTER WITH AURAL ALARM. Tyree, William H.; Bell, Thomas H. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 21 Sep 1972. Contract AT(29-1)-1106. 7p. Dep. NTIS.

A counter providing a visual and aural readout for alpha-particle detectors is described. The unit includes connections for air-proportional detectors and detector bias from an external high voltage battery. The unit has an input sensitivity of one millivolt. The quiescent battery drain is 150 microamperes. The counter has a continuous useful life of about sixteen weeks before a change of the plug-in battery pack is required. (auth)

58833 MULTICHANNEL SYSTEM FOR RECORDING NEUTRONS USING A LINE WITH AN ELECTRONIC COMPUTER. Bystritskii, V. M.; Dzhelepov, V. P.; Ermolov, P. F.; (and others) (Joint Inst. of Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 67-70 (1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 65-9(1972).

A system of instruments is described which is designed to record neutrons having energies of 1 to 10 MeV in experiments involving the study of the interactions of muons with hydrogen and other nuclei. The detectors are scintillation counters with stilbene crystals. The purpose of the electronic blocks is to separate neutrons from γ-quanta and assure that separate analysis of events with respect to neutron energy for each detector may be conducted. The entire handling process is achieved using an electronic computer and may be performed during the experiment. (auth)

58834 MEASUREMENT OF THE LIFETIMES OF THE EXCITED STATES OF NUCLEI IN THE NANOSECOND RANGE USING THE BEAM OF THE U-300 HEAVY-ION CYCLOTRON. Hagemann, U.; Neubert, W.; Stary, F.; Schulze, W. (Joint Inst. of Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 27-9(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 34-6(1972).

A fast-slow coincidence circuit is described using a planar Ge(Li)-detector and a photomultiplier. The dependence of the resolving power on the energy of γ quanta was measured. The resolving power of the system was found to be 6.5 nsec at 511 keV. Special attention was devoted to tracing the beam. (auth)

58835 USE OF A SCINTILLATION COUNTER TO MEASURE DIAGNOSTIC X-RAY TUBE KILOVOLTAGE, RADIATION EXPOSURE RATES, AND CONTAMINATION BY LOW ENERGY GAMMA EMITTERS. Henshaw, E. T.; Shaughnessy, J. T. (Liverpool Regional Hospital Board, Eng.). Phys. Med. Biol.; 17: No. 4, 577-83(Jul 1972).

A summary is made of the methods used for the following applications of the Nuclear Enterprises Scintillation counter type GP7 (phosphor of Tl activated NaI, 3mm thick, 19mm dia.): (1) Measurement of radioactive contamination. Results are presented of counts above background from 10^{-4} μCi/cm^2 of ^{125}I, ^{131}I, ^{99m}Tc, ^{85}Sr, ^{85}Rb, ^{59}Fe. (2) Measurement of diagnostic x-ray tube kilovoltage under fluoroscopic and radiographic conditions, using the K-fluorescence method. Scattering elements used were Ba, Er, Ta, Pb, U. (3) Environmental survey of a diagnostic x-ray department. In this case modification was necessary, either by inserting an 8mm thick disc of lead glass inside the probe casing between the thin crystal and the photomultiplier, or by replacement of the NaI crystal by an air equivalent plastic scintillator. Results are presented over a range 0.01 to 10 Rhr^{-1}. (UK)

58836 FIELD IONIZATION MASS SPECTROMETRY USING A SCINTILLATION DETECTOR. Wanless, G. G. (Esso Research and Engineering Co., Linden, N. J.). J. Mass Spectrom. Ion Phys.; 10: No. 1, 85-105(Nov 1972).

It is customary in FIMS work to operate with pressures of $\approx 10^{-6}$ torr in the analyzer tube but, eventually, this leads to loss of gain of the electron multiplier. Regeneration of the electron multiplier can be accomplished, but it is not convenient and usually requires removal of the detector from the mass spectrometer. A solution to this problem is found by adapting a scintillation detector to the mass spectrometer. Essentially it comprises an aluminized, bakeable scintillation crystal, a light pipe brought through a vacuum seal and a conventional sealed electron multiplier. A scintillation detector which improves signal-to-noise ratio is described, some examples are given, and further means of using the field ionization signals more efficiently are proposed. (auth)

58837 DEFECT OF PLATEAU CURVE DUE TO ELECTRIC CHARGE ON THE SOURCE BACKING FILM IN A GAS FLOW COUNTER. Watanabe, Tamaki (Nagoya Univ., Japan); Inda, Junichi; Genka, Tsuguo. Radioisotopes (Tokyo); 21: No. 2, 69-73(Feb 1972). (In Japanese).

The effect of electric charge on a radiation source contained in $4\pi\beta$ and $2\pi\beta$ gas-flow counters was examined. Serious damage on counter characteristics such as the plateau curve was produced. The lower-side anode of the $4\pi\beta$ counter was replaced by a source holder. Either a vibrating reed electrometer or a constant voltage power supply was connected between the source backing film and the cathode and current on the backing film was measured. At the same time, the plateau curves of the upper half of the $2\pi\beta$ counter were obtained. A ^{60}Co beta source on an Al foil was placed on the source holder. The plateau curves were found to be shifted to a higher supply voltage, and the ratio of the shift of the starting voltage to the source potential was ~0.26 to 0.64 varied by the dia of the source backing film and the anode shape. Higher electric resistance between the source backing film and the cathode in the $2\pi\beta$ counter produced higher plateau threshold voltage and lower plateau length, but the starting voltage was not changed. It was also found that when the counting rate of the $2\pi\beta$ was 10^4, electric resistance between the source backing film and the cathode should be maintained lower than ~10^{10} to 10^{11} Ω. (auth)

58838 FINE-GRAINED PHOTOGRAPHIC NUCLEAR EMULSION IN ELECTRON-MICROSCOPIC AUTORADIOGRAPHY. Kortukov, E. V.; Kortukova, V. M. (Kuban Medical Inst., Krasnodar, USSR). Zh. Nauch. Prikl. Fotogr. Kinematogr.; 17: No. 3, 168-74(1972). (In Russian).

The resolving powers of Russian and foreign materials used for electron microscopic autoradiography are discussed, with a characterization of more than 15 types of emulsions and the size distribution of silver halide microcrystals. The design of an ideal autoradiographic system was analyzed. The threshold of sensitivity and the limits of resolution were determined on the basis of a many-group calculation of the ionization losses of tritium beta particles and the microcrystals of AgBr. For such a system the theoretical limit of sensitivity is 100 Å; practically it is in the range 500 to 600 Å. Joint utilization of the methods of autoradiography and electron microscopy allows study of structures with a dimension of greater than 500 Å quantitatively, and down to 200 Å qualitatively. (tr-auth)

58839 SYNTHESIS OF 9-VINYLANTHRACENE. Paul, S. D.; Dhane, D. L.; Gaiki, G. M. (Bhabha Atomic Research Centre, Trombay, India). Indian J. Chem.; 10: No. 3, 321-2(Mar 1972).

The convenient synthesis of 9-vinylanthracene (I) by base-catalyzed decarboxylation of β-(9-anthracene)-acrylic acid (II) for liquid scintillation counting is described. (auth)

58840 DEAD TIME CORRECTIONS FOR X RAY INTENSITY MEASUREMENTS WITH A Si(Li) DETECTOR. Reed, S. J. B. (Australian National Univ., Canberra). J. Phys., E (London); 5: No. 10, 994-6(Oct 1972).

Dead time corrections in x ray peak intensity measurements carried out with a Si(Li) detector are large. The use of the "live time" method of timing takes account of most of the loss of counts resulting simply from the length of the pulses, but for peak measurements a further correction is required to allow for pulse pile up in the main amplifier. Dead time effects were investigated by recording the Al K peak at various count rates, using a pure Al sample with accurately measured incident electron current. A simple correction formula was found to be adequate for correcting peak intensities in spectra recorded at up to 10,000 counts/s. It was found that the use of pile up rejection did not significantly complicate the dead time correction. Measurements of Fe Kα x rays confirmed that the correction is insensitive to x ray energy, provided the live time system is used. (auth)

58841 ANALYSIS OF MAXIMUM FRAME RATES FOR GAMMA-RAY CAMERA-COMPUTER SYSTEMS. Lange, R. C.; Freedman, G. S.; Treves, S. (Yale Univ., New Haven). Phys. Med. Biol.; 17: No. 5, 624-9(Sep 1972).

It is pointed out that the prospective purchaser of a computer system designed to acquire and analyze dynamic data provided by a γ-ray scintillation camera should know how rapidly framed data can be accumulated. This problem is analyzed by considering the size of the memory available for data storage, the count rate provided by the camera, the sizes and count rates in the target and non-target regions and the dead time of the system. The maximum frame rate for a typical system was analyzed, and found to be less than ten frames per second under most conditions. A general equation is presented for calculating the maximum frame rate, applicable to any camera-computer system. The equation may also be used to estimate the frame rate for any prospective study. (auth)

58842 WINDOWLESS SEMICONDUCTOR RADIATION DETECTORS FOR MEASUREMENT OF LOW-ENERGY BETA-EMITTERS IN VIVO AND IN VITRO. Kobayashi, T. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan); Sugita, T.; Takayanagi, S.; Iio, M.; Yamada, H. Phys. Med. Biol.; 17: No. 5, 656-60(Sep 1972).

A stable, windowless p-n junction silicon detector for low-energy β-rays is briefly described. This was developed for in vivo measurements of dynamic, biomedical and bacteriological processes with radioisotopes such as ^{14}C and ^{35}S. The typical characteristics of the detectors were studied (noise capacitance, leakage current versus operating voltages over a range 0 to 40 V). Typical spectra of ^{14}C, ^{147}Pm, and ^{204}Tl are presented up to 250 keV, as shown by a 20 mm^2 sensitive area detector. A plot of counting rate against discrimination level (0 to 40 keV), and discriminator level against temperature from 0 to 40°C is presented for 20 and 200 mm^2 sensitive area detectors. The counting efficiency was proportional to the sensitive area of the detector at the constant discriminator level. Counting rate at the discriminator level of 15 keV was ~200 c.p.m. cm^{-2} for $^3/_2$ nCi cm^{-2} of ^{14}C solid source. The sensitivity of the 20 mm^2 detector was a few counts/min in μCi/ml ^{14}C solution. A test instrument for $^{14}CO_2$ measurement had been constructed for in vitro application and a block diagram of this arrangement is presented. (UK)

58843 STUDY OF THE USE OF PARTICLE CHANNELING IN TIME-OF-FLIGHT FISSION FRAGMENT MASS YIELD MEASUREMENTS. Sullivan, William John. Urbana, Ill.; Univ. of Illinois (1972). 87p. University Microfilms Order No. 72-19,941.

Thesis.

A direct physical measurement of the mass distribution from the thermal-neutron fission of U-235 was made using the single time-of-flight method and particle channeling in the energy detector. Particle channeling was employed to achieve better energy resolution. A silicon surface-barrier detector, specially designed with the [110] crystal axis direction approximately perpendicular to its face, was used as the energy detector. The detector was mounted in the gimbal ring of an orientation device with two degrees of movement. A method of aligning the detector's [110] axis direction with the fragment beam was developed using X-ray diffraction techniques and a laser beam. Channeling of fragments was achieved with about 80% of the light fragments and 55% of the heavy fragments remaining in the channels. A delta-ray detector was designed and constructed to determine the time-of-passage of a fragment through a thin timing foil. A study made of timing foils determined that a thin film of Zapon lacquer stretched over a circular ring would not scatter the fragment beam out of the detection solid angle, yet would give enough delta rays to initiate the timing process for some of the fragments. The timing efficiency of this device was measured to be about 23% and 42% for the heavy and light mass fragments, respectively. From the results of the experiment a new picture for dechanneling was postulated. Previous to this experiment it was believed that some of the heavy ions entering a detector within the critical acceptance angle for channeling were dechanneled in the metallic window. Results indicate that the fragments dechannel in the silicon detector somewhere in the middle of the fragment path, fragments entering at a larger angle to the crystalline axis having a higher probability of dechanneling. The pulse height defect, nuclear stopping defect, and the recombination defect were estimated as a function of fragment velocity. The results of the experiment suggest that channeling of fragments eliminates the nuclear stopping defect and most of the recombination defect. Although no structure in the mass distribution could be confirmed, experimental results suggest that a 1-amu mass measurement is possible. (Diss. Abstr. Int., B)

58844 LITHIUM-DRIFTED GERMANIUM DETECTORS: THEIR FABRICATION AND USE. An Annotated Bibliography. Brownridge, I. C. (comp.). New York; Plenum Publishing Corporation (1972). 220p. $20.00.

A list of 790 references on the fabrication, associated electronics, and uses of Ge(Li) detectors is presented. Brief abstracts of the publications are included. An author index and a subject index are included. (W.H.K.)

58845 MANUFACTURE OF NIP SEMICONDUCTOR PARTICLE DETECTORS WITHOUT A DEAD ZONE. Garin, Arlette; Oria, Michel; Waast, Bernard (to Commissariat a l'Energie Atomique). French Patent 2,094,616. 4 Feb 1972. Filed 26 Jun 1970. (In French).

A method of manufacturing semiconductor detectors (Ge or Si) from classical Li compensated NIP structures is presented. A useful (intrinsic) zone is obtained (2 cm thick for Ge and 1 cm thick for Si), the dead zone being eliminated by reducing the thickness of the windows. This structure can be used for very high energy particles, similar detectors being stacked one on top of the other. (France)

58846 RADIATION DETECTORS IN NUCLEAR RADIATION MEASUREMENTS. Daniels, W. R. J. Inst. Nucl. Eng.; 13: No. 5, 137-42(Sep 1972).

A survey is presented of the numerous types of radiation detectors used in nuclear radiation measurements, including the principles underlying the various detectors and their mechanisms. (UK)

58847 TRANSIENT ELECTRON CURRENT OBSERVED IN GAS IONIZATION CHAMBERS. Okabe, S.; Tsumori, K.; Tabata, T. (Radiation Center of Osaka Prefecture). Nucl. Instrum. Methods; 104: No. 1, 109-16(1972).

The gas-filled ionization chambers, irradiated with pulsed electrons or X-rays from a linear accelerator, have been found to show a transient electron current (TEC) after the applied voltage is cut off. This phenomenon has been observed in the four types of the ionization chambers tested. Building-up and decay characteristics of the TEC, effects on the TEC temperature, intensity of incident radiation, and kind and pressure of filling gas, electrode material have been investigated. From these results, the TEC is considered to be caused by gas molecules and ions adsorbed on the walls and the electrodes of the chamber. One component of the TEC is considered to affect the accuracy of ionization chamber current observed with the applied voltage. (auth)

58848 LOW-NOISE SILICON PLANAR DETECTORS FOR ROOM TEMPERATURE APPLICATION. Keil, G.; Lindner, E. (Technische Univ., Munich). Nucl. Instrum. Methods; 104: No. 1, 209-14(1972).

Oxide passivated silicon detectors (5 mm^2) were fabricated showing very low leakage currents (1 nA at 100 V) at room temperature. A thin entrance window of about 0.3 μm and a breakdown voltage of over 250 V have been obtained. This performance results from a double diffusion and a double guard-ring structure. A resolution of fwhm = 1.85 keV was measured at room temperature for the 14 keV X-rays and a fwhm = 1.96 keV for the 59 keV γ-line of ^{241}Am. Here the resolution was already limited by the charge-sensitive preamplifier and no more by the detector. The main field of application will be in nuclear medicine and biology. (auth)

58849 SIMPLIFIED EXPRESSIONS FOR THE YIELD OF NUCLEAR REACTIONS FOR THE SOLID ANGLE SUBTENDED BY A SLIT. Bontemps, A. (CEN, Grenoble, France). Nucl. Instrum. Methods; 104: No. 1, 153-5(1972). (In French).

Simplified relations are established to show what sort of slit can be chosen to diaphragm a nuclear detector in a given experiment to get the maximum yield. (auth)

58850 LOSS OF PROTONS IN THIN ABSORBERS. Renberg, P. U. (CERN, Geneva); Measday, D. F.; Favier, B.; (and others). Nucl. Instrum. Methods; 104: No. 1, 157-62(1972).

Proton losses due to nuclear inelastic interactions have been measured in Al and Cu absorbers of thicknesses less than half the proton range, for incident proton energies of 250 and 560 MeV. It is shown that the data can be used to obtain absorption corrections in proton counter telescopes for other energies in this energy interval. The absorption correction would be found from the loss calculated from the proton reaction cross-sections by multiplying by an experimentally determined ratio which is given by the present measurement. (auth)

58851 MONTE CARLO PROGRAM FOR EVALUATING THE RESPONSE OF A SCINTILLATION COUNTER TO MONOENERGETIC GAMMA RAYS. Beattie, R. J. D.; Byrne, J. (Univ. of Sussex, Brighton, Eng.). Nucl. Instrum. Methods; 104: No. 1, 163-8 (1972).

A simple technique is described for calculating the response of a NaI scintillation counter to monoenergetic γ-rays. The method employs empirically determined counter parameters and γ-ray cross-sections in a Monte Carlo routine and has been successfully applied in the analysis of internal bremsstrahlung spectra. (auth)

58852 BIFILAR HELICAL MULTIWIRE PROPORTIONAL CHAMBER FOR POSITION SENSITIVE DETECTION OF MINIMUM IONIZING PARTICLES. Lee, D. M. (Univ. of Virgnia, Charlottesville); Sobottka, S. E.; Thiessen, H. A. Nucl. Instrum. Methods; 104: No. 1, 179-88(1972).

A new type of multiwire proportional chamber with a helical cathode for delay line readout has been developed and studied in detail. It gives cathode delay line pulses nearly as large as the anode pulses, and hence is well-suited for minimum ionizing particles. Measurements on such a chamber yielded spatial resolution better than 0.33 mm fwhm for ^{90}Sr β particles, a resolving time less than 30 ns, and maximum counting rate greater than 2 MHz. The most probable pulse height induced on the delay line by minimum ionizing particles in this chamber is approximately 8 mV. (auth)

58853 GLASS DETECTORS. Lecerf, M.; Peter, J. (Laboratoire de Chimie Nucleaire, Orsay, France). Nucl. Instrum. Methods; 104: No. 1, 189-95(1972). (In French).

Glass has been irradiated orthogonally with respect to its surface by ^{12}C, ^{16}O, ^{20}Ne, ^{40}Ar, Ni and ^{84}Kr ions of energy per nucleon ranging up to 1.1 MeV/amu. The diameter of the etched particle tracks was measured as a function of the mass and velocity of the particle. It increases with the mass and energy of the projectile. The increase with mass is greatest between O and Ar and much smaller for heavier particles. The projectile detection threshold appears to occur in the vicinity of oxygen. Particles of charge greater than or equal to 10 and energy greater than 6 MeV are detected with 100% efficiency. (auth)

58854 USE OF A PILEUP REJECTOR IN QUANTITATIVE PULSE SPECTROMETRY. Bartosek, J. (Inst. of Applied Geophysics, Brno); Masek, J.; Adams, F.; Hoste, J. Nucl. Instrum. Methods; 104: No. 1, 221-3(1972).

A circuit for adequate extension of measurement time to take into account pulses rejected due to pulse pileup is proposed. The circuit was tested with a Ge(Li) spectrometer and radioactive sources. (auth)

58855 CALIBRATION OF THRESHOLD ACTIVATION DETECTORS WITH 14 MeV NEUTRONS. Cooper, P. N.; Kabir, S. M. (Univ. of Aston, Birmingham, Eng.). Nucl. Instrum. Methods; 104: No. 1, 227-9(1972).

A method is presented for calibrating threshold activation foils in a 14 MeV neutron flux and for minimizing the uncertainty in source position by rotating the foils around the source. (auth)

58856 RESPONSE FUNCTION OF A GOOD-GEOMETRY DETECTOR FOR A γ-RAY CASCADE. Erdal, B. R. (CERN, Geneva); Rudstam, G. Nucl. Instrum. Methods; 104: No. 2, 263-83(1972).

Response functions for various initial excitation energies for a good-geometry, large-volume NaI(Tl) detector assembly have been calculated by the Monte Carlo technique and by a recursion calculation. The two calculations give similar results. The calculated response functions do not exhibit any major variation as a function of level density, gamma-width, nuclear type (even, odd or odd mass) or mass (within a given mass region). (auth)

58857 STABILITY IMPROVEMENT OF IONIZATION CHAMBERS. Yarom, A.; Yair, R.; Sabbah, B. (ELSCINT Ltd., Haifa, Israel). Nucl. Instrum. Methods; 104: No. 2, 257-61(1972).

Instability of current ionization chambers was found to rise due to capacitance variations which are a result of fast humidity changes. A grid electrode was inserted between the high-voltage electrode and the collecting electrode, thus decreasing the effective capacitance and capacitance variation of the chamber. (auth)

58858 RESPONSE OF NE-228 LIQUID SCINTILLATOR TO 3.5, 5.8, AND 10.5 MeV PROTONS. Madey, R.; Waterman, F. M. (Kent State Univ., Ohio). Nucl. Instrum. Methods; 104: No. 2, 253-6(1972).

The response of NE-228 liquid and NE-102 plastic scintillators to 3.5, 5.8 and 10.5 MeV protons has been measured relative to electrons. These proton energies represent the kinetic energies of recoil protons from the elastic scattering of 14 MeV neutrons at angles of 30°, 40° and 60°. The response of NE-228 relative to that of NE-102 plastic scintillator varies from 78% for 3.5 MeV protons to 91% for 10.5 MeV protons. (auth)

58859 RESPONSE FUNCTIONS FOR SODIUM IODIDE SCINTILLATION DETECTORS. Berger, M. J.; Seltzer, S. M. (National Bureau of Standards, Washington, D. C.). Nucl. Instrum. Methods; 104: No. 2, 317-32(1972)

The response of NaI detectors to gamma rays has been calculated by a method that takes into account the multiple scattering and escape from the detector of the incident gamma rays as well as of the secondary charged particles and bremsstrahlung. The method is applicable to gamma rays with arbitrarily high energies, and its accuracy has been verified by comparisons with experimental response functions at energies up to 20 MeV. A systematic tabulation has been made of the response functions for 3'' × 3'' detectors irradiated with broad parallel beams of gamma rays, at energies between 100 keV and 20 MeV. These results are given in a parametrized form which makes it easy to interpolate with respect to incident gamma-ray energy. A few response functions have also been calculated for detectors irradiated with 50 MeV gamma rays. Exploratory calculations have shown that 3'' × 3'' detectors are ''omnidirectional'' in the sense that the shape of the response function depends very little on the direction of the incident gamma-ray beam. Therefore, the tabulated data for broad parallel beams incident perpendicularly can, in good approximation, also be applied to other source geometries, e.g. the case of a detector exposed to an isotropic gamma-ray flux. (auth)

58860 LARGE VOLUME HIGH PURITY GERMANIUM RADIATION DETECTOR. Llacer, J. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods; 104: No. 1, 249-51(1972).

The successful fabrication of a 32 cm^3 planar high purity Ge radiation detector is reported. Characteristics of the crystal and procedures for contact making are described. Detector characteristics at 4500 V bias are found to be as follows: leakage current <40 pA; detector contribution to line width at 1.33 MeV is 1.72 keV; efficiency at the same energy is 6.79%. Spectra obtained with a room temperature FET preamplifier for ^{60}Co are shown. (auth)

Radiation Dosimeters

Refer also to abstract 59042.

58861 (AED-C-21-10) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. Section 21: Dosimetry. Number 10: Electrometric Methods. Becker, Klaus (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Leopoldshafen (West Germany)). Aug 1972. 154p. (In several languages). Dep. NTIS (U. S. Sales Only).

A list of 2571 references from Nuclear Science Abstracts (NSA) from 1964 to 1970 is presented. They are categorized according to conferences, dissertations, patents, reports, journal articles, and monograms. An author and a subject index are included. (W.H.K.)

58862 (HASL-264) EVALUATION OF A THIN LiF THERMOLUMINESCENT DOSIMETER FOR RADON DAUGHTER PERSONNEL MONITORING. Shambon, Arthur; White, Otto (Health and Safety Lab. (AEC), New York). Aug 1972. 7p. Dep. NTIS.

Personal dosimeters are being developed for evaluating the exposure of uranium miners to α-emitting radon daughter products. Thermoluminescent dosimeters have been used for measurement of the α activity on filter papers collecting the radioactive aerosols in the mines. The relative responses of 0.035 in. and 0.010 in. thick LiF thermoluminescent dosimeter squares were evaluated with ^{137}Cs gamma rays and alpha particles. Tests showed that the thin LiF squares were preferable for α measurements in a mixed α, γ field, such as exists in uranium mines. A control LiF dosimeter square allowed correction for the gamma exposure. (auth)

58863 (RISO-M-1525) SCANNING SPECTROPHOTOMETER FOR READING THIN-FILM DOSIMETERS. Miller, A.; McLaughlin, W. L.; Lynggard, B. (Danish Atomic Energy Commission, Risoe. Research Establishment). Aug 1972. 22p. Dep. NTIS (U. S. Sales Only).

It is possible to convert a conventional spectrophotometer into a versatile scanning spectrophotometer, without great difficulty or expense. The improved instrument can be tailored to perform many electro-optical tasks by the appropriate arrangement of modular components. In this work, basic optical components (light sources, monochromator, and sample chamber) of a conventional spectrophotometer were used on an optical bench. Specially designed accessories were added to these components in order to measure at given wavelengths (from 200 to 800 nm) spatial variation (down to less than 10 μm) of optical transmission or reflection quantities in thin-film dosimeters, over a wide dynamic range. For high-speed data acquisition, analogue-to-digital conversion was programed to give tabular or graphical absorbed dose readings from calibrated film as a function of optical or spatial variables. (auth)

58864 USE OF CaSO$_4$:Tm POWDER FOR FAST NEUTRON DOSIMETRY. Blum, E.; Bewley, D. K.; Heather, J. D. (Medical Research Council, London). Phys. Med. Biol.; 17: No. 5, 661-2(Sep 1972).

A dosimeter is briefly described using glucose crystals to eliminate the angular dependence of response. Three parts glucose and one part CaSO$_4$: Tm powder were mixed and encapsulated in PTFE. Pure phosphor powder was used in a similar second tube, both being irradiated together. After irradiation the glucose was washed out, the phosphor dried and both tubes read out together. The dissolution and drying did not affect the thermoluminescent response. The phosphor in tube 1 gave thermoluminescence due to proton recoil reactions produced by the neutrons in the glucose. Tube 2 represented the γ-response, together with the small intrinsic neutron sensitivity. The neutron beam included about 4% of γ radiation in terms of dose to tissue. The ratio of thermoluminescence from tube 1 : tube 2 was 4 : 1. The response changed by less than 10% when the axis of the tube was turned through 90° from the center line of the beam. (UK)

58865 REDUCTION OF ABNORMAL BACKGROUND LEVELS IN LiF/TEFLON THERMOLUMINESCENT DOSIMETERS. Robertson, M. E. A. (D. A. Pitman Ltd., Surrey, Eng.); Gilboy, W. B. Int. J. Appl. Radiat. Isotop.; 23: No. 9, 439-40(Sep 1972).

Following extremely high and variable background signals reported by radiation workers using LiF/Teflon discs (12.7 mm diameter by 0.4 mm thickness) for personnel monitoring, 60 such discs were put through a standard cleaning and annealing procedure and the high backgrounds confirmed. Repeated ultrasonic cleaning with Arklone P®, followed by soaking and rinsing in pure ethyl alcohol and distilled water gave no improvement. However a 5 day soak in pure chloroform, a rinse in ethyl alcohol followed by standard annealing reduced the background to normal levels and it was shown that the TL sensitivity was unchanged. While these tests were in progress the surface contamination of dosimeters in an annealing oven after its use for setting Araldite caused problems and it is suggested that annealing ovens should be used exclusively for dosemeters. (UK)

58866 EXTENSION OF THE RANGE OF GAMMA MEASUREMENTS OF THE FARMER SECONDARY STANDARD DOSIMETER. Dardenne, J. C.; Wambersie, A. (Inst. du Cancer, Louvain, Belgium). J. Belge Radiol.; 55: No. 3, 361-4(1972). (In French).

The range of 0 to 60 R for the old models can be extended to about 0 to 600 R by the simple addition of a condenser. The technical precautions to be taken to perform this modification are described. (auth)

58867 NATIONAL PHYSICAL LABORATORY SECONDARY STANDARD THERAPY-LEVEL X-RAY EXPOSURE METER. Kemp, L. A. W. (National Physical Lab., Teddington, Eng.). Brit. J. Radiol.; 45: No. 538, 775-8(Oct 1972).

A preliminary outline account is given of the development of a secondary standard exposure meter around which a calibration service could be planned from the National Physical Laboratory. The arrangement of the ionization chamber, measuring circuit and ^{90}Sr stability check source is briefly described, and tabulated calibration factors (R/coulomb) are presented for the N.P.L. chamber over a 2 year study. (UK)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 58544.

58868 (BLG-466) DATA ACQUISITION SYSTEM FOR TWO-PARAMETER NEUTRON SPECTROMETRY. Mewissen, L. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Jun 1972. 22p. Dep. NTIS (U. S. Sales Only).

A computer program of a data acquisition system for two-parameter neutron spectrometry with flowcharts of the different phases is described. It has been implemented for an 8K computer, 16 bits word length, interfaced with a 256K disc memory. The operating procedure necessary to run the program is summarized. The Assembler listing of the program is also given in an annex. (auth)

58869 (CEA-CONF-1965) USE OF PERIOD DISCRIMINATION TO SELECT THE TIME INFORMATION IN NUCLEAR SPECTROSCOPY. Deroche, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 2 Aug 1971. 23p. (In French). (CONF-710956-2). Dep. NTIS (U. S. Sales Only).

From sixth international symposium on nuclear electronics; Warsaw, Poland (Sep 1971).

A period discriminator for extracting more precise time information from the signal from a plane Ge(Li) semiconductor in the energy spectroscopy of γ radiation was constructed. The discriminator consists of a Schmitt trigger, time information pulse shaper, baseline restorer, and a delay device. Tests on the duration of the return to zero signal showed that for a time information represented by a 5 nsec pulse, a duration of 8 nsec is sufficient to assure functioning of the delay device. The discriminator transmits correctly two pulses separated by an interval of $\geq$6 nsec. Experimental tests were made and the time uncertainty was recorded as a function of the amplitude threshold for three energy regions centered on the photoelectric peaks of ^{60}Co and ^{22}Na and on the 122-keV value sampled on the Compton front of the ^{22}Na spectrum. The results showed that the discriminator, by eliminating false alarms, made possible the detection of signals from a low amplitude threshold. (J.S.R.)

58870 (CEA-R-4275) BETA AND X-RAY SPECTROMETRY OF GASEOUS RADIOACTIVE SOURCES. Grenier, Janine; Miltenberger, Bernard (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Jun 1972. 69p. (In French). Dep. NTIS (U. S. Sales Only).

A high performance (measurement range 70 eV to 1 MeV with a low background) β-X ray gas ionization spectrometer is described. It is intended for measurements on radioactive gas sources. The spectrometer and the associated electronics are described. A detailed analysis of the background noise is presented together with the techniques adopted to minimize this noise. A method of analyzing gaseous radioactive sources using spectrometry is described; the method is based on the decomposition of the spectra. Various examples are given to illustrate the method. Results on the K/L conversion ratio are given. (France)

58871 (EIR–216) NEW METHOD FOR DETERMINATION OF DEAD-TIME CORRECTIONS OF TIME-OF-FLIGHT SPECTROMETERS. Widder, F. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Jun 1972. 24p. (In German). Dep. NTIS (U. S. Sales Only).

A new method for the determination of dead time corrections on counting rates of time-of-flight spectrometers is described. The method is especially suited for neutron time-of-flight spectrometers and is based on a least-squares fit calculation of three dead time parameters by means of target transmission values. The results obtained by this method are discussed in detail. (auth)

58872 PARALLEL PLATE AVALANCHE COUNTER TELESCOPE TO INVESTIGATE (n,α)-REACTIONS. Brede, Hein Juergen (Univ., Tuebingen, Ger.). Z. Phys.; 254: No. 4, 364-74(1972). (In German).

The characteristic features of a parallel-plate counter telescope are described. Using two dE/dx parallel-plate avalanche counters, a silicon detector, and a third parallel-plate avalanche counter in front of the target operating in anticoincidence, the counter telescope has a coincidence resolution time of 20 ns and is suitable to study (n,α) reactions, especially at large backward angles. (10 figures, 1 table) (auth)

58873 SPECTROMETRY OF SOFT GAMMA AND X RADIATION USING SEMICONDUCTOR DETECTORS (REVIEW). Baldin, S. A.; Ioannesyants, L. M. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 1-23(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 7-30(1972).

The characteristics of semiconductor materials and their effects on energy resolution, recording efficiency, and other operating parameters of semiconductor detectors are discussed. A detailed analysis is made of the peculiarities of the electronic equipment: preamplifiers with a cooled front stage, shaping amplifiers, dc restorers, and superposition rejectors. Primary attention is devoted to the technology of obtaining a high energy resolution and the latest achievements in this field. The parameters of modern spectrometers for soft γ and x radiation are presented. Also, the applications of spectrometers in nuclear physics, x ray phosphorescence analysis, and other fields are reviewed. (117 references) (auth)

58874 SEMICONDUCTOR SOFT-ELECTROMAGNETIC-RADIATION SPECTROMETER HAVING A RESOLUTION OF 550 eV. Solov'ev, S. M.; Smirnov, A. N.; Tyvin, L. I.; Eismont, V. P. Instr Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 49-52 (1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 52-5(1972).

The layout of a spectrometer with a cooled diffusion-drift Si(Li) detector and cooled field-effect transistor used as the input element of the amplifier channel is described. In order to illustrate the resolving power of the spectrometer, the spectra of soft electromagnetic radiation from ^{57}Co and ^{241}Am are presented. (auth)

58875 CORRELATION PROCESSING OF ISOLATED PEAKS ON MULTICHANNEL SPECTRA. Egiazarov, B. G.; Seld'yakov, Yu. P.; Selyutin, R. P. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 78-82(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 76-80(1972).

A method of processing equipment spectra using correlation functions is considered which is valid for calculations on an electronic computer. The results obtained have allowed this method to be applied not only for interpreting the energies of peaks, but also for estimating the relative intensities of isolated peaks with an accuracy of approximately 1%. The use of the method is especially effective for processing spectra obtained on a spectrometer using semiconductor detectors. (auth)

58876 GAMMA-RESONANCE CONSTANT-VELOCITY SPECTROMETER WITH NORMALIZATION FROM A REFERENCE MEASUREMENT. Egiazarov, B. G.; Shamov, A. I. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 53-7(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 55-8(1972).

A γ-resonance constant-velocity spectrometer is described which has normalization of the spectrum according to a reference measurement. During each period of motion the chopper produces zero, positive, and negative velocities successively. The reference measurement is carried out at zero velocity. The relative motion between the source and the absorber is produced by an electrodynamic springless chopper. (auth)

58877 CONSIDERATION OF THE OPTIMUM MEMORY CAPACITIES FOR STORAGE, AND NUMBERS OF POINTS FOR DISPLAY OF SCINTILLATION CAMERA IMAGES. Kojima, Kazuhiko; Hisada, Kin-ichi (Kanazawa Univ., Japan). Radioisotopes (Tokyo); 21: No. 2, 86-91(Feb 1972). (In Japanese).

As radiation due to radioisotope decay is emitted, data analysis is accomplished by digital methods. A computer is used for storage, calculation, and display of image data obtained by a scintillation camera and scanner. An ideal computer for this purpose is an on-line system with an image memory unit, a central processing unit, and a display unit. At the present, either a minicomputer or a small hard computer is used with a memory unit and a processing unit. Memory capacities for calculation depend on the purpose of processing but 8 k words are enough for complicated calculations. Capacities needed for data storage are 16 ~ 20 k memory elements (8 bits/element), and 5×10^4 counts must be accumulated to make an image. About 16 ~ 100 k points are needed for cathode-ray tube display. To increase display points, an interpolation method instead of expansion of expressive magnetic core method is used. (auth)

58878 X-RAY FLUORESCENCE ANALYSIS USING SEMICONDUCTOR DETECTORS AND RADIOACTIVE SOURCES. Mateiciuc, V.; Aldea, L.; Constantinescu, M.; Stadnicov, T. Chim. Anal. (Bucharest); 2: No. 2, 128-31(1972). (In Rumanian).

The possibility was studied of determining the lead in solid mixtures of lead and iron, lead and antimony, tungsten in solid mixture of tungsten with antimony as well as of zirconium in an indigenous zirconiferous sand, by the method of the excitation of fluorescence X radiations with sources of ^{141}Ce, ^{57}Co and ^{241}Am, using as detectors crystals of Ge(Li) and Si(Li). The sensitivity limit of the method is 0.5% for lead and tungsten. (auth)

58879 PULSE PILE-UP REJECTION IN Si(Li) X RAY DETECTION SYSTEMS. Reed, S. J. B. (Australian National Univ., Canberra). J. Phys., E (London); 5: No. 10, 997-1000 (Oct 1972).

Pulse pile-up is significant in Si(Li) x ray spectra because of the long main amplifier time constants used. It is undesirable because it causes spurious coincidence peaks and increases background. Pile-up rejection, using a fast amplifier to resolve nearly coincident pulses, greatly reduces pile-up effects. At low energies the choice of time constants in the rejection amplifier becomes critical if x ray pulses are to be distinguished from noise. The results of experimental investigations of the optimum settings of the rejection system are described. (auth)

58880 NEW METHOD FOR MEASUREMENT OF γ-RAY POLARIZATION BY DETECTION OF ANGULAR CORRELATION IN PAIR PRODUCTION. Kobayashi, M. (National Lab. for High Energy Physics, Oho-machi, Japan); Kondo, K. Nucl. Instrum. Methods; 104: No. 1, 101-7(1972).

A method of measuring γ-ray polarization by observing the angular correlation in pair production is proposed. The method consists in taking a correlation between one dimensionally projected angles of the emitted electron and positron. A large analyzing power can be obtained for those pairs whose projected emission angles are large with the same sign, although it generally accompanies a small intensity. If the projected emission angles are limited to within 1.5 reduced angles, the maximum analyzing power is about 0.71. (auth)

58881 HIGH POTENTIAL ELECTRON PRE-ACCELERATOR FOR USE WITH A MAGNETIC BETA-RAY SPECTROMETER. Morinobu, S. (Tokyo Inst. of Tech.); Ikegami, H. Nucl. Instrum. Methods; 104: No. 1, 93-100(1972).

A new electron pre-accelerator has been constructed for use with a sector type double focusing beta-ray spectrometer. High accelerating potentials of up to 55 kV are available without deteriorating the intrinsic resolution of the spectrometer. For analyzing electrons of above 1 keV, the apparatus has greatly reduced the difficulties in preparing thin counter windows. The use as an electrostatic analyzer is also possible for extremely low energy electrons by applying small decelerating potentials in front of the accelerating field. The high pre-accelerating potential makes a fast coincidence experiment available even for the electrons of below 1 keV. The time resolution is limited only by the flight-time spread for electrons in the spectrometer. Good applicabilities to the electron spectroscopy are demonstrated using sources of ^{57}Co, ^{110m}Ag and ^{85}Sr. (auth)

58882 DEVICE FOR MAINTAINING A CONSTANT DETECTOR COUNTING RATE FROM A DECAYING RADIOACTIVE SOURCE. Thomas, R. N.; Thomas, R. V. (Bedford Coll., London). Nucl. Instrum. Methods; 104: No. 1, 137-9(1972).

A device is described with which the counting rate in a detector used to measure the gamma-ray spectrum of a decaying radioactive source may be kept constant, by controlled movement of the source towards the detector. A stabilization of counting rate to within ±1% of the desired magnitude is obtained over a period of several half-lives. An alternative application of the same circuit enables a replenishment of the source whenever the counting rate falls below a pre-set level. (auth)

58883 ASYMMETRIC LINEAR Ge(Li)-Ge(Li) SUM-PEAK COINCIDENCE SPECTROMETER. Helppi, H.; Kantele, J. (Univ. of Jyvaeskylae, Finland). Nucl. Instrum. Methods; 104: No. 1, 141-5(1972).

An asymmetric linear Ge(Li)–Ge(Li) sum-peak coincidence spectrometer configuration has been designed and tested. In this system, the ratio of the gains of two detector-amplifier chains is chosen around 1.2 to 1.3, and pulse amplitudes or addresses due to coincident events are summed. The simple method introduced involving a single run which results in two spectra (separated according to which detector records the larger energy) appears to be quite useful in $\gamma\gamma$ coincidence and directional correlation measurements, especially in laboratories where no event-by-event data acquisition hardware is available. (auth)

58884 Ge(Li)–NaI(Tl) γ–γ-COINCIDENCE SPECTROMETER FOR NON-DESTRUCTIVE DETERMINATION OF COPPER TRACES IN BIOLOGICAL MATERIALS BY NEUTRON ACTIVATION. Simonits, A. (MTA Kozponti Fizikai Kutato Intezete, Budapest). Izotoptechnika; 15: No. 5, 255-66(May 1972). (In Hungarian).

The calibration, determination of efficiency, and the calculation of sensitivity are described. (auth)

58885 PULSE SHAPE DISCRIMINATION WITH NE 211 LIQUID SCINTILLATOR. Syme, D. B. C. B.; Crawford, G. I. (Univ. of Glasgow). Nucl. Instrum. Methods; 104: No. 1, 245-7(1972).

NE211 liquid scintillator is shown to have comparable neutron-gamma ray pulse-shape discrimination properties to the NE213 over a wide dynamic range. (auth)

58886 DETECTOR FOR EFFICIENT BACKSCATTER MOESSBAUER EFFECT SPECTROSCOPY. Keisch, B. (Carnegie-Mellon Univ., Pittsburgh). Nucl. Instrum. Methods; 104: No. 1, 237-40(1972).

An efficient detector for backscatter Moessbauer effect spectroscopy was developed specifically for examination of works of art containing iron-bearing pigments. The detector, which was designed for 14.4-keV γ rays, is filled with 90% Kr and 10% methane. Performance of the detector is outstanding with the resolution for 14.4 keV γ rays approximately 1.8 keV (fwhm) after being freshly filled. The performance slowly deteriorates during the first three or four days but then holds constant for about two months. (F.S.)

High Energy Physics Instrumentation

Refer also to abstract 59396.

58887 (RPP/N–26) OPERATION OF A TRACK SENSITIVE HYDROGEN TARGET IN A 500 LITRE NEON–HYDROGEN BUBBLE CHAMBER. Ayres, J. F.; Coleman, T. G.; Damerell, A. R.; (and others) (Rutherford High Energy Lab., Chilton (England)). Jun 1972. 16p. Dep. NTIS (U. S. Sales Only).

A 20 liter hydrogen filled track sensitive target was successfully operated in the 1.5 m cryogenic bubble chamber at the Rutherford High Energy Laboratory. The chamber was filled with a mixture of neon and hydrogen at a concentration of 45 mole % neon giving a radiation length of 860 mm. Satisfactory track quality in both target and chamber was achieved and 65,000 pictures were obtained in a 4 GeV/c π^+ beam. (auth)

58888 LOW PRESSURE STREAMER CHAMBER IN A MAGNETIC FIELD. Anisimova, N. Z.; Davidenko, V. A.; Dolgoshein, B. A.; Somov, S. V.; Starosel'tsev, V. N. (Moscow Engineering-Physics Inst.). Zh. Eksp. Teor. Fiz.; 63: No. 1, 21-3(Jul 1972). (In Russian).

The operation of a low pressure streamer chamber ($P = 1.3$ to 15 torrs) in a magnetic field of $H = 0$ to 9 kG is investigated. It is shown that the localization of tracks at such pressures in a plane perpendicular to the electric field is not worse than in the case of a chamber working at normal pressure. The dependence of the streamer diameter and electron diffusion coefficient in the track on magnetic field strength is derived. (auth)

58889 CODING OF INFORMATION FOR TRANSMISSION FROM A REGISTER INTO A STORAGE DEVICE. Zhuravlev, N. I.; Kuznetsov, A. S.; Sinaev, A. N. (Joint Inst. of Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 90-2(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 86-8(1972).

A network is described for coding information when it is transmitted from a number register into a storage device or electronic computer. Potential signals at the output of the network characterize both the number of the lowest register digit situated in the "1" state and the number of such neighboring digits in a binary code. The network is designed using elements with potential couplings, which allows the information-coding time to be reduced, the network to be simplified and the operating reliability of the network to be increased. The network is designed primarily for acquisition of information from ferrite matrices in wire spark chambers. (auth)

58890 FAST LOGIC BLOCKS BASED ON INTEGRATED ELEMENTS. Aul'chenko, V. M.; Korshunov, Yu. V.; Khabakhpashev, A. G. (Inst. of Nuclear Physics, Novosibirsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 87-9 (1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 83-5(1972).

A description is given of fast electronic blocks which have been developed for experiments with colliding beams. The use of integrated circuits in such blocks allows considerable reduction of the dimensions and a considerable increase in the reliability of the electronic circuitry. The principal characteristics of a universal block based on integrated elements are presented. (auth)

58891 SHOWER EFFICIENCY OF SPARK CHAMBERS. Korenchenko, S. M.; Mitsel'makher, G. V.; Nekrasov, K. G. (Joint Inst. of Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 61-3(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 60-2(1972).

A phenomenological model of the development of several breakdowns in a single gap of a spark chamber is proposed which considers fluctuations in the time which it takes for streamers to form. It was found that the linear efficiency may be defined by means of two parameters—the efficiency with which one particle is recorded, and the shunting parameter. A satisfactory agreement with experimental data is obtained. (auth)

58892 STABILIZATION OF THE DIMENSIONS OF THE RASTER OF A MEASUREMENT TELEVISION AUTOMATON. Klevalin, V. A.; Petrakov, A. V.; Gorelova, V. I. Instrum. Exp. Tech. (USSR) (Eng. Transl.); 15: No. 1, 64-6(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 63-5(1972).

A system for stabilizing the dimensions of the raster of a transmitting television tube in a high-precision measurement automation for taking information from spark chambers is considered. Under these conditions periodic calibrations of the measurement complex may be eliminated. The block diagram and characteristics of the system are presented as they were obtained on a mockup. (auth)

58893 EFFECT OF REDUCTION REACTIONS ON THE THRESHOLD SENSITIVITY OF NUCLEAR PHOTOGRAPHIC EMULSIONS. Kalashnikova, V. I.; Lemeshko, B. D. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 71-2(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 69-71(1972).

Estimates are obtained of the threshold power of the developing centers and the minimal exposures as a function of the number of Ag atoms contained in a sensitivity center. It is shown that reduction reactions which lead to an increase in the amount of Ag on the surface of the microcrystals lower the sensitivity of nuclear photographic emulsions. (auth)

58894 USE OF AN RFK-5 PHOTOGRAPHIC CAMERA IN THE START-STOP MODE. Agan'yants, A. O.; Vartapetyan, G. A.; Danielyan, V. D.; (and others) (Erevan Physics Inst.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 76-7(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 75-6(1972).

A simple photographic system is described for taking off information, and for troubleshooting and checking the communication between high-energy physics experiments and an electronic computer; the system is based on using a camera in a mode unprovided for in its construction—gated operation of the motor with the initial position of the RFK-5 camera with its window shut. The system is distinguished by reliability and noise immunity. (auth)

58895 GIANT BUBBLE CHAMBER GARGAMELLE. Musset, Paul; Rousset, Andre (CERN, Geneva). Rev. Fr. Elec.; 45: No. 237, 13-23(1972). (In French).

The operating principles of bubble chambers are reviewed and their uses in studying high energy interactions between elementary particles are discussed. The technical specifications of the heavy liquid bubble chamber, Gargamelle, are described in detail. The first neutrino and antineutrino experiments carried out using the CERN proton synchrotron are presented together with the research program envisaged for the coming years. (France)

58896 RESPONSE OF THE LIQUID SCINTILLATORS NE 230 TO DEUTERONS AND NE 231 TO PROTONS. Bertl, W.; Breunlich, W.; Chalupka, A.; Tagesen, S. (Inst. fuer Radiumforschung und Kernphysik, Vienna). Nucl. Instrum. Methods; 104: No. 1, 205-7(1972).

Response data have been deduced from energy spectra of elastic-scattering recoils. For deuterons in NE 230 the energy range covered was 1 to 7 MeV, for protons in NE 231 it was 4 to 13 MeV. (auth)

58897 AUTOMATIC SPARK CHAMBER SYSTEM WITH SONIC AND MAGNETOSTRICTIVE READ-OUT. Bentley, K. R. (Univ. of Birmingham, Eng.); Davies, J. D.; Dowell, J. D.; (and others). Nucl. Instrum. Methods; 104: No. 2, 299-316(1972).

A spark chamber system with sonic read-out operating as a magnetic spectrometer is described. Operational and design information is given and the choice of type of read-out and spark chamber gas is discussed. Magnetostrictive beam chambers are included in the system and an account is given of our experiences in reading out from the high voltage wire planes and of the problems associated with long sensitive times. Performance data for both types of spark chamber are presented. (auth)

58898 MULTIWIRE PROPORTIONAL CHAMBER SYSTEM FOR USE IN A LARGE GAP MAGNETIC SPECTROMETER. Blum, D.; Boucrot, J.; Grossetete, B.; McGill, W.; Ngoc, H. Nguyen (Paris Univ., Orsay, France). Nucl. Instrum. Methods; 104: No. 2, 285-97(1972).

A set of nine multiwire proportional chambers (1700 wires) on-line with a computer has been used in a photoproduction experiment at the Orsay Linear Accelerator. Triggered with scintillation counters, they have allowed the complete magnetic analysis of particle trajectories. The chamber properties are investigated before and after 3500 hours of use. Some original features developed for this experiment are described in detail; data acquisition and event reconstruction with the computer are discussed. (auth)

58899 MULTIWIRE PROPORTIONAL COUNTER WITH INTEGRAL READOUT DELAY LINE. Gilland, J. R.; Emming, J. G. (Ball Brothers Research Corp., Boulder, Colo.). Nucl. Instrum. Methods; 104: No. 1, 241-3(1972).

A multiwire proportional counter which has an output signal delay related to ionizing event position is described. A spatial resolution of ±0.2 mm has been measured, using P10 gas and simple electronics. Higher resolutions should be possible with high gas gain mixtures. (auth)

58900 BACKGROUND CAUSED BY TRITIUM DISINTEGRATION IN DEUTERIUM CHAMBERS. Yoshiki, H. (Institut fuer Hochenergiephysik, Heidelberg). Nucl. Instrum. Methods; 104: No. 1, 231-2(1972).

It is shown that not all β-rays from tritium contained in deuterium make bubbles. This would reduce the cost of deuterium for the bubble chamber operation. (auth)

Radiometric Instruments

Refer also to abstract 58522.

58901 DENSITIES OF AMORPHOUS Si FILMS BY NUCLEAR BACKSCATTERING. Brodsky, M. H.; Kaplan, D.; Ziegler, J. F. (IBM Watson Research Center, Yorktown Heights, N. Y.). Appl. Phys. Lett.; 21: No. 7, 305-7(1 Oct 1972).

The backscattering of 2500-keV alpha particles is used to measure the densities of amorphous Si films. The density of amorphous Si is found to be inversely proportional to the electron spin resonance signals. The extrapolated density at zero spins is equal to 1.01 ± 0.02 times that of crystalline Si. The highest density achieved in a real amorphous film was 0.97 ± 0.02 times the crystalline density. (auth)

58902 IMPROVEMENTS TO RADIOLOGICAL EQUIPMENT. Loucheur, Rene; Louche, J. C. P. (to Compagnie Generale de Radiologie). French Patent 2,088,964. 7 Jan 1972. Filed 30 Apr 1970. (In French).

Radiological equipment enabling tomographies and pictures to be taken at oblique incidence with a variable focal distance is presented. The equipment operates in a continuous manner without any mechanical intervention, the quasi-linear trajectories being traced at the focused position in the tube. The column containing the tube generating the radiation is composed of two parts having parallel longitudinal axes. The first part is connected to a horizontal axis housed in the body of the equipment; a motor permits the column to pivot about this axis. The part supporting the radiogenic tube is housed in the first part and moves longitudinally with respect to the axis of this first part. The stator of the electrical motor controlling this displacement is fixed to the first part, a spindle attached to the rotor being mechanically coupled to the second part. The motor is controlled as a function of the angle of inclination of the column by an electrical servomechanism. (France)

58903 IMPROVEMENTS IN OR RELATING TO SOURCES OF BETA OR OTHER IONISING RADIATION. Ansell, Kenneth Harding; Fletcher, Keith Ernest (to United Kingdom Atomic Enerty Authority). British Patent 1,283,356. 26 Jul 1972. Filed 3 Oct 1968.

A need has arisen for a β-source of maximum energy <200 keV for thickness gauging of thin materials. Such a source for industrial use must be compact, robust and safe, be low in cost and use a nuclide available at high specific activity in non-volatile form, with a half-life greater than a year. The only feasible nuclides readily available are ^{14}C and ^{63}Ni, but neither is obtainable at high specific activity and both are expensive. The system described provides a source of scattered β-radiation. It comprises an extended container the construction of which is such as to act as a shield against the direct β-radiation. One side of the container supports a target material opposite an extended window through which the scattered β-radiation can penetrate. In this way the spectrum of a comparatively high energy but otherwise suitable β-emitter is suitably modified. The container is preferably of stainless steel and the window comprises a thin Al strip. (UK)

58904 ANALYSIS OF SURFACE LAYERS BY ELASTIC BACKSCATTERING. Turos, A.; Wielunski, L. (Inst. of Nuclear Research, Warsaw). Nucl. Instrum. Methods; 104: No. 1, 117-24 (1972).

A method for the analysis of surface layers by elastic backscattering of low energy heavy charged particles is described. This method allows the determination of the thickness of thin films and surface layers, as well as the identification of elements which are present in the investigated target. The total amount of a given kind of nuclei in a surface region may also be evaluated. Presented applications of the backscattering technique to some typical cases indicate the usefulness of the method. (auth)

58905 TEMPERATURE SENSING BY NEUTRON TRANSMISSION. Harms, A. A.; Garland, W. J. (McMaster Univ., Hamilton, Ont.). Nucl. Instrum. Methods; 104: No. 1, 217(1972).

In a study using neutron transmission as a temperature sensor, results suggest that neutron transmission could be used to monitor the medium temperature in the smelting and refining industry. The use of ^{252}Cf makes this method feasible and practical. (F.S.)

58906 PROPOSAL OF A METHOD FOR 14 MeV NEUTRON HIGH INTENSITY PULSE GENERATION. Taczanowski, S. (Inst. of Nuclear Techniques, Krakow). Nucl. Instrum. Methods; 104: No. 1, 219-20(1972).

The idea of storage rings applied to a neutron generator's deuteron beams and the production of neutron pulses suggests that when the neutrons are not produced, the storage of the deuteron beam in the magnetic field and later the extraction of the beam should create target current pulses of multiplied intensity. Corresponding neutron pulses should have high yield and duration no longer than the circulation period of the deuterons in the magnetic field. This would produce short neutron pulses and provide optimum use of the neutron source. This idea is applicable to activation analysis. (F.S.)

Radiation Effects on Instrument Components, Instruments, and Electronic Systems

Refer also to abstracts 58847, 59312, and 60393.

58907 (UCRL-73872) X-RAY-INDUCED INTERFACE STATES IN SiO_2-Si AND CARRIER LIFETIME STUDIES IN ELECTRON-BEAM IRRADIATED SiO_2. Kalibjian, R.; Mayeda, K.; Ciarlo, D. R.; Boster, T. A. (California Univ., Livermore. Lawrence Livermore Lab.). 8 Sep 1972. 10p. (CONF-721008-2). Dep. NTIS.

The interface state density in x-ray irradiated SiO_2-Si is determined. For 10^5 rads, the deep acceptor and donor states are 5 to 9×10^{12} states/eV-cm^2 (about one order of magnitude larger than that of the non-irradiated samples). Also, lifetime studies in SiO_2 are made in a time-of-flight type of experiment using an electron beam for the ionizing source. By direct experiment, the lifetime of electrons in SiO_2 is shown to be less than 7 nsec. (auth)

58908 RADIATION DAMAGE BY THERMAL NEUTRONS IN Si(Li) NUCLEAR RADIATION DETECTORS. Burmeister, R. (Paedagogische Hochschule, Dresden). Phys. Status Solidi (a); 13: No. 1, K37-9(16 Sep 1972).

The β spectrum of ^{137}Cs was recorded with a Si(Li) detector as a function of bias voltage after irradiation with 2.7 × 10^{11} thermal neutrons/cm^2. The satellite peak on the low-energy side of the 625-keV main peak is due to impurity voids of $(V + Li_i)^-$ complexes. The impurity level of the $(V + Li_i)^-$ center was found 0.18 eV below the conduction band. Charge collection efficiency was also used as a radiation damage indicator; for a neutron dose of 2.7 × 10^{11}/cm^2, the damage constant was found to be $k = 1.6 \pm 0.4 \times 10^{-5}$ cm^2 s^{-1}. (D.L.C.)

58909 Li-DRIFTED SILICON SURFACE BARRIER DETECTORS IRRADIATED BY 0.5- TO 1.5-MeV ELECTRONS. Nakamoto, Shunsuke (Chubu Inst. of Tech., Kasugai, Japan); Aoki, Takashi; Kawabata, Keishi. Jap. J. Appl. Phys.; 11: No. 10, 1576(Oct 1972).

Radiation damage effects in Si(Li) surface-barrier detectors were studied with electrons at 0.5 to 1.5 MeV at doses of 10^3 to 10^{15}/cm^2. The capacitance at low reverse-bias decreased at low dosages and increased at higher dosages. The increase of the capacitance was enhanced by thermal annealing. The phenomena are discussed. (W.H.K.)

58910 AMPLIFICATION OF ELECTRONIC CURRENT DURING IRRADIATION OF CRYSTALS AND FILMS OF A_2B_6 BY FAST ELECTRONS. Panova, V. G.; Fedorus, G. A.; Fursenko, V. D. Poluprov. Tekh. Mikroelektron.; No. 6, 76-80(1971). (In Russian).

The dependence of the amplification factor (γ) of the electron current in A_2B_6 compounds as a function of the energy and intensity of the electron beam is investigated in a wide interval of values: (5 to 40 keV and 10^{-12} to 10^{-8} A/cm^2). It is shown that in highly sensitive single crystals of CdS and CdSe during steady 30-keV electron excitation and 20 V potential applied to the specimen, $\gamma \approx 10^8$. The maximum possible value γ_{max} is estimated with E = 30 keV under extreme conditions, which for single crystals of CdS can attain values of 10^{11}. (JPRS)

58911 ABOUT THE PERFORMANCE OF IMPLANTABLE PACEMAKERS UNDER HIGH ENERGY IRRADIATION OF A BETATRON. Eipper, H. H.; Laufenberg, E. (Strahlenklinik im Staedtischen Krankenhaus, Cologne). Strahlentherapie; 143: No. 6, 644-54(Jun 1972). (In German).

Investigations into the performance of implantable pacemakers under high energy electron and photon irradiation of a betatron showed independence of pacemaker pulse shape with radiation dose rate, yet pacemaker frequency varied with increasing dose rate. This variation being slight with respect to the relatively low dose rates administered in radiotherapy, no danger is to be expected for patients with implanted pacemakers. This has been approved in a clinical case. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 58737, 58765, 58819, 58877, 60154, and 60534.

58912 (EUR-4100(Rev.1972)) CAMAC: A MODULAR INSTRUMENTATION SYSTEM FOR DATA HANDLING. Revised Description and Specification. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug 1972. 64p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 85.-.

CAMAC is a modular data handling system in widespread use with on-line digital computers. It is based on a digital highway for data and control. The CAMAC Specification ensures compatibility between equipment from different sources. This revised specification introduces several new features, but is consistent with the previous version (EUR 4100 e, 1969). The CAMAC system was specified by European laboratories, through the ESONE Committee, and has been endorsed by the USAEC NIM Committee, who have an identical specification (TID-25875). (auth)

58913 (FRNC-R-13) CONSTRUCTION OF A PULSE GENERATOR FOR TESTING NUCLEAR SPECTROMETRY UNITS. Richard, Alphonse (Conservatoire National des Arts et Metiers, Paris (France)). 1972. 87p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A stable pulse generator having an integral linearity of better than 10^{-5} was constructed. The drift is less than 1 part in 10^5 per month and the amplitude dispersion always less than $\pm 8.10^{-6}$. The use of an 18 bit digital analog coding enabled an amplitude resolution twice as high as that initially sought to be obtained (4.10^{-6} of the spectrum instead of 10^{-5}). The linearity is in all cases superior to 4.10^{-6}. The overall characteristics allow the generator to be used to test all the preamplifiers, threshold amplifiers, and amplitude coders used in nuclear spectrometry units. The profile of the amplitude coders is obtained numerically from the amplitude (automatic progression) in the form of a binary signal proportional to the amplitude of the pulses because of the small value of the amplitude dispersion, this measurement is effected with a definition of 1/30 of a channel using an 8000 channel coder. (France)

58914 (HMI-B-123) INVESTIGATIONS AND ELECTRONIC IMPLEMENTATION OF AUTONOMOUS INFORMATION TRANSFER BETWEEN PROCESS INSTRUMENTATION AND ON LINE COMPUTER. Pangritz, H. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Jun 1972. 132p. (In German). Dep. NTIS (U. S. Sales Only).

A proposal is made for the organization of autonomous data transfers between process instrumentation and on line computer. In order to implement this proposal it is discussed, whether a minicomputer is suitable for controlling the data transfers between process instrumentation and main computer, and which features of such a control computer are required for handling a fairly large data rate. A hardware controller designed for this application is described, the major design criteria being high flexibility in hardware extensions, control performance and computer independence. This controller allows a data rate of 30,000 words/sec with 24 bit per word, when using an appropriate on line computer. The process instrumentation may consist of an unlimited number of data sources and data sinks with different priorities allocated. (auth)

58915 (LA-4947) EMP IN THE IONOSPHERE: ROCKET TEST 152-133. Benton, C. U.; Wakefield, R. L.; Niper, E. D.; Schellenbaum, R. L. (Los Alamos Scientific Lab., N. Mex.). Sep 1972. Contract W-7405-eng-36. 15p. Dep. NTIS.

The third in a series of rocket EMP experiments was conducted October 30, 1971 during the Barbizon exercise. The flight test of new instrumentation was primarily for the observation of the propagation characteristics of EMP-type signals at altitudes between 100 and 280 km. Two ground-based EMP simulators with close-in sensors, two ground-based ionosondes, a C-135 aircraft, and a 9-in. Nike-Tomahawk rocket were used to conduct the experiment. Development of instrumentation for this experiment, data from the experiment, and experiment planning are discussed. (auth)

58916 (LBL-326) CAMAC CONCEPTS. Mack, Dick A. (California Univ., Berkeley. Lawrence Berkeley Lab.). 2 Sep 1971. Contract W-7405-eng-48. 20p. (CONF-710846-1). Dep. NTIS.

From Conference on advances for electronics in astronomy; Licks Observatory, Santa Cruz, CA. (31 Aug 1971).

CAMAC is a digital data-handling system, incorporating a modular equipment approach, designed to communicate via a data transfer highway with a computer. Mechanical, electrical and logic features are specified to provide system compatibility. Developed by the ESONE Committee of European Laboratories, CAMAC has become adopted internationally as a standard for data acquisition and control. (auth)

58917 (UCRL-50007-72-1) HAZARDS CONTROL PROGRESS REPORT NO. 42, JANUARY-APRIL 1972. (California Univ., Livermore. Lawrence Livermore Lab.). 26 Jul 1972. Contract W-7405-Eng-48. 16p. Dep. NTIS.

AIR SAMPLERS—development of environmental monitoring constant-flow
BETA SPECTROMETERS—development of ionization chamber
EXHAUST SYSTEMS—fire protection for air filter, using water sprays
GLOVE BOXES—fire extinguishing system for
RAD. DET., DIELECTRIC TRACK—track counting methods for
RAD. DOS., THERMOLUMINESCENT—readout system for
SAFETY HAZARDS—control at LLL, Jan.-April, 1972
URINE—monitoring for tritium, development of portable kit for
(W.H.K.)

58918 SIMULATOR OF AN ARBITRARY TIME SPECTRUM OF PULSES. Finogenov, K. G.; Markina, I. S. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 116-19(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 107-9(1972).

An electronic generator is described which creates a random sequence of pulses whose average frequency varies in time in accordance with a stipulated law. The instrument allows the time spectra of an arbitrary shape to be simulated and serves to debug and monitor the operation of the electronic channel of a time spectrometer for the microsecond range. (auth)

58919 SHAPER WITH A FOLLOW-UP THRESHOLD, WHICH IS DESIGNED FOR INCREASED LOADINGS. Meleshko, E. A.

Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 120-2 (1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 112-13(1972).

A description and the characteristics are given for a shaper having a follow-up threshold, which is designed for operation under conditions of increased input loadings. The working range of the input amplitudes of the shaper is from 0.5 to 5 V. The variation of the repetition frequency of the input pulses (having an amplitude of 2 V and a leading-edge duration of 3 nsec) from 10^4 to 10^7 Hz changes time position of the output pulses by no more than 0.05 nsec. The shaper is designed principally for the shaping of start and stop pulses in nanosecond time spectrometers. (auth)

58920 NANOSECOND-SIGNAL INTEGRATOR WITH CONTROL. Budyashov, Yu. G.; Zinov, V. G.; Krasnoborodov, B. S. (Joint Inst. of Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 123-5(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 114-15(1972).

A network is described which is designed for linear gating of nanosecond signals with simultaneous lengthening of them to a duration which ensures normal operation of a multichannel analyzer. The magnitude of the pedestal from the control signal is controlled and may be either positive or negative. (auth)

58921 NUCLEAR MAGNETIC RESONANCE SPECTROMETER USING A SUPERCONDUCTING MAGNET AND DIGITAL DATA PROCESSING: APPLICATION TO SINGLE CRYSTAL VANADIUM. Hechtfischer, D.; Karcher, R.; Lueders, K. (Freie Univ., Berlin). Appl. Spectrosc.; 26: No. 5, 549-52(1972).

A nuclear magnetic resonance spectrometer is described, which was constructed to investigate metals and especially metal single crystals at temperatures between 1.5 and 300°K and at fields up to 5 tesla units (T; 1 tesla unit = 10 kG). A superconducting NbTi magnet system was built with adjustable compensation coils. Data acquisition takes place using the Hewlett—Packard timer-counter, model 5326 B, in connection with remote programming allowing subsequent exact data processing with a computer. An example is given for a vanadium single crystal, the resonance frequency of which has been measured in the range from 110 to 230°K. (auth)

58922 AN INTRODUCTION TO CAMAC. Costrell, L. (National Bureau of Standards, Washington, D. C.). CAMAC Bull.; No. 2, 3-6(Nov 1971).

The CAMAC instrumentation system developed by the ESONE Committee of European laboratories has been endorsed by the US AEC NIM Committee as a dataway system complementary to the NIM (Nuclear Instrument Module) system. CAMAC is described in a general way in this condensed version of the introductory paper of the CAMAC Tutorial Sessions of the 1970 IEEE Nuclear Science Symposium. (EURATOM)

58923 DEVELOPMENT OF A $\pi/2\sqrt{2}$ CYLINDRICAL ELECTROSTATIC SECTOR. Perrier, P.; Carricaburu, B. (Univ., Toulouse). Rev. Phys. Appl.; 7: No. 1, 61-7(Mar 1972). (In French).

A cylindrical electrostatic sector with an angle of deflection of $\pi/2\sqrt{2}$ is described. The optical properties of such a system are presented and the aberration terms which limit the energy resolution are calculated. It is intended to be used to analyze electrons scattered by solid targets. (auth)

58924 VARIABLE TEMPERATURE CRYOSTAT (1 TO 300°K) FOR NEUTRON DIFFRACTION. Sougi, M. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Phys. Appl.; 7: No. 1, 29-34 (Mar 1972). (In French).

A cryostat designed for neutron diffraction studies at constant temperature (1 to 300°K), which can be used in a magnetic field, is described. A very low thermal conductance is interposed between the resistor sample-heater and the cold source (liquid helium). Thermal exchange between the sample and the cold source may be regulated by an activated charcoal device which controls the insulation vacuum. (France)

58925 RATIOMETER FOR MEASURING THE RELATIVE ABUNDANCES OF TWO IONS USING A SINGLE COLLECTOR MASS SPECTROMETER. Guern, Y.; Johannin-Gilles, A. (Univ., Brest, France). Method. Phys. Anal.; 8: No. 1, 39-42 (Mar 1972). (In French).

A ratiometer was developed for use in conjunction with a single collector mass spectrometer for the measurement of the relative abundances of two ions. The instability of the ion source is compensated by an almost immediate comparison of the mass peaks. The mass peaks are alternately scanned across the exit slit at high speed by a modulated accelerating potential. The resultant ion current is demodulated synchronously with the input modulation. Two memory systems are used to transform these ion currents into dc currents. The comparison of the two corresponding potentials gives the relative abundance ratios. (France)

58926 MULTI-CHANNEL ANALYSER SYSTEM IN CAMAC. Sanghera, D. (EKCO Instruments Ltd., Southend-on-Sea, Eng.). CAMAC Bull.; No. 3, 9(Mar 1972).

The techniques of multi-channel analysis are well established and various designs incorporating a digital computer have been implemented in the past. CAMAC offers a simple, modular, and powerful analysis hardware at low cost. A multi-channel analyzer system using CAMAC-compatible units and a general purpose digital computer (Honeywell H.316) is described. (EURATOM)

58927 CESIUM ION SOURCES FOR ION SPUTTERING. Perron, C.; Baril, M. (Univ. Laval, Quebec). Rev. Phys. Appl.; 7: No. 1, 21-2(Mar 1972). (In French).

A simple alkaline ion source was developed in order to produce the primary ion beam of a few keV, for the sputtering ion source of a mass spectrometer. This source, using a power of about 30 W, is able to produce an ion beam of the order of 10^{-5} A for more than 100 hours. A unipotential lens was added to the source, so that an ion density of 100 $\mu A/cm^2$ on a surface of 0.5 mm^2 can be obtained. (France)

58928 ELECTRICAL SWITCHING EFFECTS IN VANADIUM-OXIDE COMPLEXES. Yu, Ruey Jang. East Lansing, Mich.; Michigan State Univ. (1972). 147p. University Microfilms Order No. 72-22,300.

Thesis.

The electrical properties of oxidized vanadium foils were investigated. One-mil-thick sheets of vanadium, diced into approximately 1 by 1 mm squares, oxidized in air at 475°C for up to one week, and then mounted in a spring-loaded sample holder were found to exhibit reversible, nondestructive, current-controlled switching as well as inductance effects. From the x-ray-diffraction patterns and the conductivity-versus-temperature data, it was concluded that these oxidized samples were in the amorphous state; furthermore, the oxidized layers were not VO, VO_2, V_2O_5, etc., but rather appeared to be a combination of oxide complexes. The ratio of a typical sample's "off-state" to "on-state" resistance was observed to be approximately 100. The breakdown voltage ranged from 3 to 10 volts and was found to decrease as the bath temperature was increased. The delay time for the device to switch was measured and found to be dependent upon the ambient temperature, as well as the magnitude of the applied voltage. The inductance of a typical sample was found to be strongly dependent upon the dc bias current but independent of frequency, suggesting possible applications as a varactor. For the case of zero dc bias, inductances in excess of 100 mH were observed; however, the Q of the structure was quite low. An expression for the threshold voltage required for the sample to switch from the low-conductance to high-conductance state was obtained in terms of the sample's thermal conductivity and rate of change of electrical conductivity with temperature. The expression was found to be basically in agreement with experiments. The negative resistance of the unit was also observed, and it was shown that the formation of a current channel does not necessarily imply that the material must exhibit negative-differential resistance. Finally, a criteria for observing the negative-differential resistance in current-controlled, bulk-switching devices was established. (Diss. Abstr. Int., B)

58929 DAMPER FOR A PIEZOELECTRIC TRANSDUCER OPERATING UNDER IRRADIATION. Fignon, Marcel (to Commissariat a l'Energie Atomique). French Patent 2,097,451. 3 Mar 1972. Filed 7 Jul 1970. (In French).

A transducer for use in conjunction with an ultrasound nondestructive testing system suitable for use in a neutron flux is described, the checking of a nuclear reactor vessel being envisaged. Different types of crystals can be used; each different type leads to a different conception. The damper consists of a metallic cylinder, having a diameter at least equal to that of the crystal, and coated (if necessary) with a metallic deposit. The damper is provided with a weld for positioning the crystal. (France)

58930 IMPROVEMENTS TO MASS SPECTROMETERS. Vassenaix, Michel (to Thomson-CSF). French Patent 2,094,410. 4 Feb 1972. Filed 19 Jun 1970. (In French).

This invention concerns improvements to compact magnetic deflection spectrometers in which the whole spectrometer (including the ion source) is subjected to a deflecting magnetic field. The spectrometer is provided with two semi-plates for guiding the ion beam, which are parallel to the lines of force of the magnetic field. The spectrometer is coupled at its exit to a generator generating a function which cancels out the effect of the magnetic field near the ion source. (France)

58931 EQUILIBRIUM PRESSURES OF THE HYDROGEN–NIOBIUM SYSTEM AS SECONDARY STANDARDS FOR ULTRA-HIGH VACUUM GAUGE CALIBRATION. Titcomb, C. G.; Wallace, W. E. (Univ. of Pittsburgh). J. Vac. Sci. Technol.; 9: No. 5, 1253-5(1972).

A small, simple arrangement using a H–Nb solution that was used to calibrate gages directly over the complete range 10^{-8} to 10^{-1} torr is described. Made entirely of glass, the system consists of a solution cell containing the specimen of Nb, the gas measuring volume, and the gas reservoir, interconnected by means of two bakeable metal valves. The solution of H in Nb is suitable because equilibria between H and the metal can be attained quickly at temperatures as low as 195°K; at 273°K the equilibrium pressure in the two-phase region is only 1.2×10^{-8} torr. (1 figure) (R.W.R.)

58932 DEAD-TIME LOSSES IN A BUFFERED DATA RECORDING SYSTEM. Oeveras, H. (CERN, Geneva). Nucl. Instrum. Methods; 104: No. 1, 85-91(1972).

Expressions are derived for the average fraction of events that will be stored (i.e. not lost) when completely random events (i.e., with exponentially distributed interarrival times) are fed through a buffer with capacity n events into a data store with constant dead-time (service time). The data store can be synchronized with a clock of any cycle time. Transfer times are neglected, except between the buffer and the data store. (auth)

58933 MAGNETIC TAPE INTERFACE FOR NUCLEAR DATA 130 MULTICHANNEL ANALYZER AND KENNEDY 1400 TAPE TRANSPORT. Frame, J. M.; Van Nice, H. L. (Washington State Univ., Pullman). Nucl. Instrum. Methods; 104: No. 1, 215-16(1972).

A digital electronic interface to link a Kennedy 1400 tape transport to a Nuclear Data 130 multichannel analyzer has been built and tested. (auth)

58934 CURVED SILICON CRYSTALS AS NEUTRON MONOCHROMATORS. Antonini, M. (Comitato Nazionale per l'Energia Nucleare, Ispra, Italy); Corchia, M.; Nicotera, E.; Rustichelli, F. Nucl. Instrum. Methods; 104: No. 1, 147-52(1972).

Curved silicon crystals to be utilized as neutron monochromators have been produced by forming a film of Si_3N_4 on one face of the crystal. The curvature effects have been detected by optical interference and γ-ray diffraction. Neutron diffraction measurements have been performed in a white neutron beam and the absolute reflectivities have been measured by a double crystal spectrometer. The results are in agreement with a simple model based on the dynamical theory of diffraction by perfect crystals. From this model an optimum radius of curvature can be estimated for which the whole volume of the crystal participates in the diffraction process giving the highest neutron reflectivity for a given wavelength resolution. (auth)

58935 KILOAMPERE CURRENT AND CHARGE MEASUREMENTS OF A 2 MeV PULSED ELECTRON SOURCE. Dick, C. E.; Whittaker, J. K.; Sparrow, J. H. (National Bureau of Standards, Washington, D. C.). Nucl. Instrum. Methods; 104: No. 1, 131-6 (1972).

A current monitor has been developed to measure the electron current pulse from the NBS 2 MeV pulsed electron generator. This monitor features low inductance and a risetime of the order of a hundred picoseconds, enabling it to faithfully reproduce high frequency components present in the electron beam pulse. In addition, a charge integrating system comprised of an integrating capacitor and a precision integrator has been developed to measure the total charge contained in the electron beam pulse. (auth)

58936 AUTOMATIC FOCUSING OF SCANNING MICROSCOPES. Goel, B.; Eggmann, R. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods; 104: No. 1, 225-6(1972).

A method is reported which allows automatic focusing of scanning microscopes with the aid of commercially available image analysers. (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

Refer also to abstracts 58573 and 58777.

58937 (CEA-R-4308) MASS CONVECTION IN A TUBE WITH WALL SUCTION. Mordchelles-Regnier, Georges (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1972. 118p. (In French). Dep. NTIS (U. S. Sales Only).

An attempt was made, in the framework of a research program on isotopic separation by gaseous diffusion, to evaluate the effect of the flow conditions of a gaseous mixture on the concentration profile, and in consequence, on the variations in the composition of a mixture diffusing across a porous wall. The following concepts are introduced: the aerodynamic diffusion efficiency and the diffusion thickness. Equations for these two quantities were established from the mass spectrum of the exhausted mixture, dimensional analysis and an analogy with transport phenomena, turbulent flow and the case where the molar titer of one of the constituents is very small being considered. A correction was made for the wall suction effect. The real value of this correction was determined from experiments conducted with a mixture of argon isotopes. The experimental results confirm the validity of the theoretical approach adopted. (France)

58938 (MLM-1943) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION: APRIL—JUNE 1972. (Mound Lab., Miamisburg, Ohio). 18 Aug 1972. Contract AT-33-1-GEN-53. 29p. Dep. NTIS.

Research on separation and purification of isotopes is reported. Progress is reported on carbon isotope separation, stable gaseous isotope separation, thermal diffusion research, research on transport properties, and research on liquid thermal diffusion. (J.R.D.)

58939 ELECTROMAGNETIC SEPARATION OF SHORT-LIVED ISOTOPES OF RADON, XENON, AND KRYPTON. Afanas'ev, V. P.; Gromova, I. I.; Monchka, D.; Ryko, V. I. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 41-3(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 45-7(1972).

A procedure is described for separating short-lived isotopes of Rn, Xe, and Kr. The values of the separation efficiency are presented. The isotopes obtained were used for spectroscopic investigations of α- and β-decay and γ-radiation from these isotopes. (auth)

58940 IMPROVEMENTS IN OR RELATING TO ION BEAM SEPARATORS. Freeman, James Harry (to United Kingdom Atomic Energy Authority). British Patent 1,280,011. 5 Jul 1972. Filed 5 Feb 1969.

The ion beam separator described comprises a curved ion beam passageway, a deflecting magnet the pole pieces of which are located one on each side of the passageway and curved to conform to the shape of the latter. At least one pole piece includes a movable portion to effect adjustment of the angle of the pole piece end face relative to the center line of the ion beam passageway. The separator is preferably provided with means for moving at least part of the deflecting magnet independently; this may comprise a guide trackway. (UK)

58941 PROCEDURE FOR MONOTHERMAL TYPE AMINE-HYDROGEN ISOTOPIC EXCHANGE: AN INSTALLATION USING THE PROCEDURE OUTLINED. Arnauld, Jean-Pierre; Dirian, Gregoire; Mambert, Irma; Roth, Etienne (to Commissariat a l'Energie Atomique). French Patent 2,094,429. 4 Feb 1972. Filed 19 Jun 1970. (In French).

A monothermal type isotopic amine-H_2 exchange process, effected by countercurrent circulation in one or more isotopic exchange columns, is presented. A nitrogen—hydrogen mixture (NH_3 synthesis gas) with a liquid amine containing a catalyst in solution, and possibly an adjuvant are used. The deuterated liquid amine coming from the isotopic exchange columns, and containing the catalyst, is depleted by exchange with deuterium depleted ammonia gas. The catalyst contained in the amine is regenerated by separating from the NH_3 before recycling the amine. The amine contained in the deuterium enriched ammonia gas is separated. The amine contained in the synthesis gas is also separated. (France)

58942 MONOTHERMAL TYPE NH_3–H_2 ISOTOPIC EXCHANGE INSTALLATION. Arnault, Jean-Pierre; Dirian, Gregoire; Lambert, Irma; Roth, Etienne (to Societe Chimique des Charbonnages). French Patent 2,095,180. 11 Feb 1972. Filed 19 Jun 1970. (In French).

This monothermal type NH_3–H_2 isotopic exchange process is effected by countercurrent circulation in one or several isotopic exchange columns. A nitrogen—hydrogen mixture (NH_3 synthesis gas) and liquid ammonia gas and an adjuvant are used; the solution also contains a catalyst. The deuterated liquid ammonia coming from the isotopic exchange columns and containing the adjuvant and catalyzer is depleted by exchange with deuterium depleted ammonia gas. The deuterium depleted liquid ammonia is recycled; the adjuvant is separated from the deuterium enriched ammonia gas; the ammonia gas is then sent into the ammonia cracking plant. The adjuvant contained in the syntheses gases is separated before these gases are sent into the NH_3 synthesis plant. Primary, secondary, or tertiary amines (trimethylamine), or an ether—oxide may be used as the adjuvant. (France)

58943 MONOTHERMAL TYPE NH_3–H_2 ISOTOPIC EXCHANGE INSTALLATION. Arnault, Jean-Pierre (to Societe Chimique des Charbonnages). French Patent 2,094,428. 4 Feb 1972. Filed 19 Jun 1970. (In French).

This monothermal type NH_3–H_2 isotopic exchange process is effected by countercurrent circulation in two isotopic exchange columns, and utilizes liquid ammonia gas and an N_2–H_2 mixture (ammonia synthesis gas), a catalyst being in solution in the liquid NH_3. The deuterated liquid ammonia gas coming from the isotopic exchange columns and containing the catalyst is deuterium depleted by isotopic exchange with pure deuterium depleted NH_3 gas. The exchange is effected at a pressure which is slightly less than the critical NH_3 pressure. The deuterium depleted liquid ammonia is recycled directly to the head of the isotopic exchange column. Deuterium enriched ammonia gas is sent into the NH_3 cracking plant. (France)

58944 URANIUM ENRICHMENT. Gerard, F. Ind. At. Spatiales; 16: No. 2, 7-8(Mar 1972). (In French and English).

A European consortium has examined the possibility of constructing a U enrichment plant for the use of European and non-European clients. The gas diffusion technique is envisaged. This plant will not be placed under the control of Euratom. The problems posed by the competition are examined in view of the reduced demand for enriched U when breeder reactors are put into service. (France)

58945 ENRICHING EUROPE WITH THE GAS CENTRIFUGE. Mohrhauer, H. (Bundesministerium fuer Bildung und Wissenschaft, Bonn). New Sci.; 56: No. 814, 12-16(5 Oct 1972).

The high cost of electricity in Europe has given the Anglo-German-Dutch gas centrifuge project a lead over the conventional diffusion process for making "enriched" uranium fuel for nuclear reactors. With their first batch of centrifuges about to enter service, the tripartite members are becoming increasingly optimistic about obtaining a major part of this billion dollar enrichment business. (auth)

58946 URANIUM ENRICHMENT IN EUROPE: PAST EXPERIENCE AND PROSPECTS. Scuricini, G. B. (Comitato Nazionale per l'Energia Nucleare, Rome). J. Brit. Nucl. Energy Soc.; 11: No. 4, 353-9(Oct 1972).

The development of U enrichment and the likely consequences of Britain's membership in the European Economic Community on the enrichment situation are reviewed. An outline is given of the position prior to 1965, during which period Capenhurst and Pierrelatte were installed, and also of the various stages of progress at international level, leading to the formation of CENTEC, URENCO and EURODIF. Existing research programs in the UK, France, Germany, the Netherlands and Italy are summarized. The separation processes of gaseous diffusion, ultracentrifugation and Trenndüse are considered in relation to the existing situation and also to their future potential. Various problems are considered which may prove a hindrance to the development of European enrichment programs. It is concluded that the entry of the UK into the EEC will lead to competitive undertakings in the world market for enriched U and plant components. (UK)

58947 ISOTOPE SEPARATION WITH HEAT BALANCING. Nazzer, Don Barkley (to Canadian General Electric Co., Ltd.). U. S. Patent 3,690,830. 12 Sep 1972. Priority date 30 Nov 1968, Canada.

The heat exchange provisions for a heavy water separation plant first stage having a plurality of parallel flow sub-stages permits selective isolation of one of the sub-stages from the plant, with the provision of thermal compensation to the plant to maintain thermal balance of the process. (Official Gazette)

Isotopic Power Sources

Refer also to abstract 59256.

58948 (BNWL–1308-11) PACIFIC NORTHWEST LABORATORY ISOTOPE DEVELOPMENT PROGRAMS QUARTERLY REPORT: MAY–JULY 1972. Jarrett, J. H. (comp.) (Battelle Pacific Northwest Labs., Richland, Wash.). Aug 1972. Contract AT(45-1)-1830. 30p. Dep. NTIS.

Research progress is reported on low-cost Cs and Sr sources; evaluation of large-scale uses for fission product Xe; SrF_2 compatibility with capsule materials; recovery and uses of fission product Rh, Pd, Ru, and Tc; neutron radiography using ^{252}Cf; advance source technology; circulatory support systems; nuclear techniques for seabed mineral exploration; and recovery of fission product ^{90}Sr and ^{137}Cs. (J.R.D.)

58949 (DP–1310) SAVANNAH RIVER LABORATORY ^{60}Co POWER AND HEAT SOURCES. Quarterly Progress Report, April–June 1972. Angerman, C. L. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug 1972. Contract AT(07-2)-1. 16p. Dep. NTIS.

Research programs are reported on ^{60}Co to provide data that will be required for designing, fabricating, and operating ^{60}Co heat sources. Primary emphasis is on selecting materials for encapsulating cobalt fuel forms and establishing temperature limits for operation of capsules in normal and accident environments. Development of specific heat source concepts is not at present included in the scope of the SRL program, but assistance is provided when required for the development and testing of demonstration units. No detrimental effects of the compatibility or oxidation reactions were indicated by measurements of the hardnesses of these zones in superalloy capsules heated up to 20,000 h at 1000°C. Satisfactory performance was demonstrated for 10,000 h in vacuum at 1400°C with a W-25 wt % Re alloy capsule containing inactive Co metal wafers. Satisfactory encapsulation of inactive CoO wafers in iridium was prevented by previously undetected cracks in the as-machined capsule components and the as-received stock material. The Nickel 201 being used to fabricate the core of the WANL demonstration heat source exhibited satisfactory oxidation resistance in 2000-h tests at 1000 and 1125°C. The thermoelectric generator fueled with ^{60}Co continued to operate satisfactorily after 16 months with an electrical output of 51.1 watts. (auth)

58950 (MLM–1935) HEAT SOURCE CAPSULE FABRICATION TECHNOLOGY PROGRAM: FINAL REPORT, JANUARY 1971–MARCH 1972. Wendeln, D. E.; Coffey, D. L.; Kreider, H. B.; Tucker, P. A.; Wyder, W. C.; Wysong, J. R. (Mound Lab., Miamisburg, Ohio). 31 Jul 1972. Contract AT-33-1-GEN-53. 152p. Dep. NTIS.

The development phase of the Heat Source Capsule Technology Program started in April of 1970 was continued to August 1971. In the period January 1971 to August 1971 the major goal was to reduce the amount of out-of-roundness of the body capsules after forming and before machining and to optimize the previously established forming and machining techniques. Dimensional and metallurgical inspections were performed on all development parts to insure conformance to drawings and specifications. A Brew Model No. 902 High-Temperature Vacuum Annealing Furnace with a hot zone 12 by 12 by 24 in. was installed, calibrated, and placed in operation in January 1972. Nine hydroformed liner assemblies were fabricated, inspected, welded, and used in the Pioneer Backup Test Capsules. Twenty-one dimensions on liner caps were checked for conformance to the drawings. Out of a total of 795 measurements there were 24 deviations noted and only eight of these were greater than 0.001 in. Fifteen dimensions on liner bodies were checked for conformance to drawings. Out of a total of 570 measurements there were 19 deviations noted and only one of them was greater than 0.001 in. Twenty-eight dimensions on strength member caps were checked for conformance to drawings. Out of a total of 644 measurements there were 42 deviations reported and only five of these deviations were greater than 0.001 in. Twenty-five dimensions on strength member bodies were checked for conformance to drawings. Out of a total of 533 measurements there were 57 deviations. Forty of these deviations were greater than 0.001 in. Sixteen dimensions on clad caps were checked for conformance to the drawings. Out of a total of 373 measurements there were 15 deviations and only one of these was greater than 0.001 in. Seven of the 15 deviations were in the wall thickness in the weld area. Nineteen dimensions on clad caps were checked for conformance to the drawings. Out of a total of 594 measurements there were 19 deviations with 10 greater than 0.001 in. Eight of these deviations were found in the dome wall thickness. In summary there have been 156 items inspected and six of these have been rejected which is a rejection rate of 3.8%. There have been 3,509 individual measurements made of which 145 were determined to be deviant which is 4.1%. Strength member bodies and caps appear to present the biggest challenge, and the problems in these cases originate in the hydroforming process. The strength member caps have the highest percentage of deviations (6.5%) only because they have been machined out of specification to provide a better weld joint with the strength member bodies. (auth)

58951 (MLM–1945) MOUND LABORATORY ISOTOPIC POWER FUELS PROGRAMS: APRIL–JUNE 1972. (Mound Lab., Miamisburg, Ohio). 31 Aug 1972. Contract AT-33-1-GEN-53. 44p. Dep. NTIS.

Research progress is reported on ^{238}Pu fuels including multihundred watt development, coating of PuO_2–Mo cermets, encapsulation of PuO_2 in Mo cups, fuel pellet fabrication, O/Pu ratio in pressed PuO_2 fuels, effects of outgassing on fuels, and creep of refractory metals and alloys. Results of studies directed to evaluation of graphite dies, and production of 1-W PuO_2–Mo cermet heat sources are also included. (J.R.D.)

58952 (ORNL–4814) ORNL ISOTOPIC POWER FUELS QUARTERLY REPORT FOR PERIOD ENDING JUNE 30, 1972. Lamb, Eugene; Donnelly, R. G. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 29p. Dep. NTIS.

Preparation for cutting samples from the tungsten fuel block of the Kilowatt Heat Source for metallographic examination is underway. Installation of test facilities for studies of helium release and identification of other volatile species released from vented fuel forms in a high-temperature, high-vacuum environment container is 50% completed. A large batch of Gd_2O_3 microparticles was prepared for use in making an experimental Ir–Gd_2O_3 cermet. Tests to determine the effect of alpha damage on the helium permeation of metals were initiated. The x-ray diffraction study of the fuel sample from the Curium Source Test showed that the fuel was $^{244}Cm_2O_3$, but due to high radiation levels from the ^{244}Cm no conclusion as to impurities or concentration could be made. The preliminary design of a process for separating curium from fission products has been completed. The process consists mainly of removing the lanthanide-actinide fraction by solvent extraction in a differential extraction system. The laser beam velocity measurement system has been installed and tested with the impact gun. Repeatability of the impact gun is excellent. Variable mechanical properties obtained on Pt–Rh–W sheet were traced to tungsten segregation and/or surface defects. Inspection and processing changes have been instituted to overcome these problems. Annealing temperatures have been determined for optimum formability, and mechanical properties are shown to be nondirectional in finished sheet. The mechanical properties of iridium sheet were determined as a function of temperature. No sharp ductile-to-brittle transition temperature was observed. The effects of a simulated reentry heat pulse on the mechanical properties of iridium were also determined. TZM was found to be incompatible with low-pressure oxygen at 1000°C. Reduced ductility is also observed in TZM exposed to CO at 1000°C. Compatibility testing of a wide variety of nonfuel materials couples has been completed and examined in support of the DART program. (auth)

58953 BY-PRODUCT ISOTOPES. Post, Roy G.; White, Donald H. (Univ. of Arizona, Tucson). pp 321-34 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

A brief review on the current status of by-product radioisotopes and their application is given in order to bring the economic potential of by-product isotopes into perspective. The possible conservation of scarce mineral resources such as the noble metals Rh and Pd by the economic production of by-product isotopes ^{103}Rh and ^{107}Pd is discussed. Similarly, the gaseous by-products ^{85}Kr and Xe isotopes from nuclear fuel reprocessing plants are evaluated as possible economic materials. Other potentially economic applications include instrumentation, heat and power systems, tracers, and irradiation processing of foods and industrial materials. (P.C.H.)

Radiation Sources

Refer also to abstracts 58618, 58749, and 58953.

58954 ^{252}Cf PROGRESS. Californium-252 Progr.; No. 12, 1-72(Jul 1972).

ACTIVATION ANALYSIS—neutron source for, detection limits of californium-252
CALIFORNIUM-252—uses of, demonstration center for evaluating
  —research on, developments in
  —availability and sales of
  —handling and storage of, facility for
  —neutron flux from, enhancement of
COAL—mining of, use of californium-252 neutron source for process control in
GRAPHITE—analysis of fuel elements containing evaluation of californium-252 neutron source for nondestructive
NEUTRON SOURCES—uses of californium-252, in geology, radiology and radiotherapy
  —use of californium-252, for process control in coal mining
  —detection limits of californium-252, in activation analysis
  —evaluation of californium-252, for nondestructive analysis of graphite fuel elements (R.C.K.)

58955 INFORMATION MEETING ON STERILIZATION TECHNIQUES OF MEDICAL AND SURGICAL INSTRUMENTS BY IONIZING RADIATIONS. Conference Held in Lyon, France, November 18, 1971. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 93, 1-79(Jan 1972). (In French). (CONF-711144).

Ten articles are included; a separate abstract was prepared for each. (P.C.H.)

For abstracts of individual papers see: 58960, 58968—58970, 59003—59006, 59336, and 59367.

58956 RADIOACTIVE HEAT SOURCE. Lonadier, Frank D.; Kershner, Carl J. (to United States Atomic Energy Commission). U. S. Patent 3,677,958. 18 Jul 1972. Filed 6 Nov 1968.

A radioactive heat source is described which comprises a porous element formed by compacting intermixed ratios of matrix and rare earth type particles, and impregnating with polonium radioisotope, with pores or interstices of the element providing for escape of helium which may result from radioisotope decay. (Official Gazette)

Design and Fabrication

Refer also to abstract 58903.

58957 (DP-MS-72-40) NEUTRON SOURCES OF PALLADIUM–^{252}Cf OXIDE CERMET WIRE. Mosley, W. C.; Smith, P. K.; McBeath, P. E. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 16 Aug 1972. Contract AT(07-2)-1. 10p. (CONF-720902-6). Dep. NTIS.

From National topical meeting on the applications of californium-252; Austin, TX. (11 Sep 1972).

Palladium-^{252}Cf oxide cermet has been developed as a versatile, safe source form for ^{252}Cf with low contamination potential. Developmental wire containing 1.85 mg of ^{252}Cf has been sold in three orders to U.S. commercial encapsulators. Bare palladium-^{252}Cf oxide cermet wire containing ^{252}Cf concentrations of 5, 50, or 500 μg/inch is expected to be offered for general sale in the near future. (auth)

58958 IRRADIATION APPARATUS WITH A ROTARY LOCK AND WITH RAMS TO MOVE OBJECTS TO BE IRRADIATED. Sieber, Adolf (to Sulzer Brothers, Ltd.). U. S. Patent 3,686,502. 22 Aug 1972. Priority date 20 Sep 1968, Switzerland.

The goods to be irradiated are moved by fluid actuated rams into a rotary lock and then into a chamber where the goods are moved about a radiation source by other fluid actuated rams. The goods are moved from the rotary lock in a forward manner and then displaced therefrom for movement about the radiation source. The goods are returned to the rotary lock in a reverse manner. (Official Gazette)

58959 METHOD FOR PRODUCING STANDARD γ AND β–γ ACTIVE SOURCES IN EPOXY RESIN FOR THE CALIBRATION OF SCINTILLATION COUNTERS. Chylinski, Andrzej; Gryglas, Hanna (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 17: No. 2-3, 199-203(1972). (In Polish).

Radioactive ^{137}C, ^{60}Co, and ^{90}Sr + ^{90}Y sources were prepared by introducing the chlorides of these isotopes into an epoxy resin. The optimum specific activity was found to lie between 100 and 300 μCi/g. The required polymerization conditions were determined. The sources thus prepared had precise geometric dimensions, a good thermal stability up to 70°C and were chemically inert; they functioned better than liquid sources. One of their most important characteristics was the uniform distribution of the radioactive material throughout the mass of the source. The source intensity was found to be accurate within 1%. (TTT)

58960 DEVELOPMENT OF A γ RAY IRRADIATION CENTER SPECIALIZED IN THE STERILIZATION OF MEDICAL ITEMS. Gouget, P.; Taponier, J. (Conservatome Industrie, Lyon). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 93, 47-51(Jan 1972). (In French).

From Meeting on sterilization techniques of medical and surgical instruments by ionizing radiations; Lyon, France (18 Nov 1971). See CONF-711144.

A new installation with a ^{60}Co source suitable for radiosterilization has been developed at the DAGNEUX center. This installation can be represented by nine different parts. The irradiator is described. It consists of three source-holder panels A, B, and C, and two conveyers. The total power of the source is divided as follows: 45% for A and C and 10% for B. An activity of 10^6Ci can be handled. The source-holders can be submerged in a pool having a depth of 7.50m. The γ radioactivity of the water of the pools is controlled by passing the water across filtering plugs. (France)

Industrial Uses

Refer also to abstracts 58624, 58756, 59005, 59006, 59336, and 59367.

58961 (CEA-CONF-1996) ^{137}Cs IRRADIATORS. Emery, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 3p. (In French). (CONF-720439-2). Dep. NTIS (U. S. Sales Only).

From International conference on the chemical arts; Paris, France (20 Apr 1972).

The economic and technical advantages of ^{137}Cs in small and medium-size irradiators for radiosterilization of medical articles and foods are summarized. (J.S.R.)

58962 (TID-26131) RADIOISOTOPES IN RESEARCH. (Oak Ridge Associated Universities, Inc., Tenn. (USA). Special Training Div.). 1971. 188p. Dep. NTIS.

Outlines of experiments used for training personnel on the uses of radioisotopes in research are presented. Radiation safety rules are included along with information on administrative rules, federal regulations on atomic energy, protective equipment and radiation warning signs. (J.R.D.)

58963 DEVELOPMENT OF IRRADIATION STERILIZED CODFISH CAKES. Heiligman, F.; Rice, Lucy J. (Army Natick Labs., Mass.). J. Food Sci.; 37: No. 3, 420-2(1972).

Studies were made on the production of a shelf stable, highly acceptable radiosterilized fish item that can be used in military and civilian feeding systems. The results showed that high-quality, well accepted codfish cakes, that will remain stable at room temperature (21°C) for long periods of time, can be produced. The fishcakes were sterilized by γ or electron irradiation and given a 12-D sterilizing dose (3.2 Mrad at -30 ± 10°C). They had a tendency to darken when held in storage, particularly when storage temperatures were elevated. The irradiated fishcakes stored at 38°C, although darker than those stored at lower temperatures, scored in the acceptable range up to 4-month storage, but were considered unacceptable after 9-months storage. No differences in product quality were detected due to type of irradiation. (P.C.H.)

58964 COMPARISON OF PRE-COOKED IRRADIATED CHICKEN AND LAMB WITH AND WITHOUT PARTIAL DEHYDRATION. Agarwal, S. R.; Heiligman, F.; Powers, E. M. (Army Natick Labs., Mass.). J. Food Sci.; 37: No. 3, 469-72 (1972).

Studies were made on the usefulness of the dehydroirradiation process for the preservation of lamb and chicken. The results showed that γ irradiation of enzyme-inactivated meats at doses as low as 1.0 Mrad can produce shelf stable, acceptable meat items. This dose requirement can probably be reduced to 0.5 Mrad by partial dehydration of the meats prior to the irradiation treatment. Although partial dehydration caused slight discoloration and toughening of texture of the chicken and lamb, the combined process did produce meat items that were acceptable, free from microbial spoilage and Cl. botulinum toxin during storage without refrigeration for 2 to 3 months, the longest storage time investigated. (P.C.H.)

58965 POSSIBLE IDENTIFICATION OF AN IRRADIATION TREATMENT OF FISH BY MEANS OF ELECTRICAL (AC) RESISTANCE MEASUREMENT. Ehlermann, D. (Institut fuer

Strahlentechnologie, Karlsruhe, Ger.). J. Food Sci.; 37: No. 3, 501(1972).

The use of an electronic device (Fish–Tester) for the measurement of irradiation treatment of fish is described. Fish–Tester readings are based on the simultaneous use of an ac current at 1 and 16 kHz. It was found that at a radiation dose of 200 krad, the Q(1,16)-values were significantly different from the Q(1,16)-value for unirradiated trout. Therefore, it is proposed to estimate the age of trout from the Q(16,100)-values, and then use the radiation sensitive Q(1,16)-values to determine a radiation treatment and possibly also the dose. It is hoped that a radiation treatment with a dose of about 100 krad (which dose is likely to be used in commercial applications) can be recognized by the use of better suited frequencies. (P.C.H.)

58966 ASEPTIC BOTTLING INTO PAPER AND PLASTIC BOTTLES. Coster, D. R. A. Fluess. Obst.; 38: No. 6, 253-60(1971). (In German).

A survey of the range of application of paper and plastic bottles and containers is presented. The possibilities of aseptically bottling foodstuffs, especially liquids, into such containers are discussed. As a result of radiation-induced injuries that have been observed in animal experiments, the use of irradiation is rejected, not only for the packing method outlined but also in general. (GF)

58967 FLOW-THROUGH IRRADIATOR FOR THE EXTRA CORPOREAL IRRADIATION OF FLUID. Vizzini, Thomas A.; Grat, Felix R. (to Radiation Machinery Corp.). U. S. Patent 3,683,183. 8 Aug 1972. Filed 4 Jun 1969.

A flow-through irradiator for fluids is described that consists of a radiation absorbing biological shield which houses a radioactive source, a non-linear conduit traversing the shield housing for passage of a fluid in a radiation receiving relation to the radioactive source, and a flexible radiation absorbing means movably interposed between the radioactive source and fluid to be irradiated to selectively vary the radiation dose rate received by fluid passing through the conduit. (Official Gazette)

58968 DEVELOPMENT OF RADIOSTERILIZATION TECHNIQUES THROUGHOUT THE WORLD. Cornuet, R.; Eymery, R. (CEN, Grenoble, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 93, 12-15(Jan 1972). (In French).

From Meeting on sterilization techniques of medical and surgical instruments by ionizing radiations; Lyon, France (18 Nov 1971). See CONF-711144.

Radiosterilization is used extensively for medical and surgical equipment. Electrons or γ rays from ^{60}Co are used. American companies (ETHICON in particular), the British Atomic Energy Authority, and the Danish Atomic Energy Commission have played an important part in developing these techniques. The Budapest conference of the IAEA concerned the radiosterilization of medical articles and tissues and the preparation of radiovaccines. (France)

58969 BACTERIOLOGICAL PROBLEMS POSED BY THE RADIOSTERILIZATION OF DISPOSABLE PLASTIC MEDICO-SURGICAL APPARATUS AND QUALITY CONTROL TECHNIQUES. Benazet, F.; Godard, C. (Societe des Usines Chimiques Rhone-Poulenc, Vitry-sur-Seine, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 93, 18-28(Jan 1972). (In French).

From Meeting on sterilization techniques of medical and surgical instruments by ionizing radiations; Lyon, France (18 Nov 1971). See CONF-711144.

The bacteriological problems posed by the radiosterilization of disposable (after use) plastic apparatus and medical-surgical equipment were studied. Such items are radiosterilized while in their packing; each packing contains only one item and is impermeable to microorganisms. Packets are thus supplied, which contain the following sterilized items: syringes, probes, transfusion equipment, and artificial kidneys. The radiosterilization characteristics can be derived from the inactivation curves; these curves represent the number of microorganisms surviving as a function of the dose, semi-logarithmic co-ordinates being used. The dose utilized depends upon the degree of contamination of the objects to be sterilized, the safety margin sought, and the radiosensitivity of the microorganisms on the items before sterilization. The source is calibrated with a reference source in order to effect the necessary dosimetry. The efficiency of the sterilization process is thus controlled and thus the extent of the sterilization of the items treated. The recommendations of the IAEA Code of Practice and the USP XVIII are briefly considered. (France)

58970 TESTS ON PACKING MATERIALS: MICROBIAN PERMEABILITY OF THE PACKING MATERIAL. Bonet-Maury, P. (Institut du Radium, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 93, 52(Jan 1972). (In French).

From Meeting on sterilization techniques of medical and surgical instruments by ionizing radiations; Lyon, France (18 Nov 1971). See CONF-711144.

A test for verifying the sealing of radiosterilizable packing with respect to microbe contamination is presented. A square of the packing material was placed on a nutritive gelatin material in a Petri dish. A Pseudomonas culture was deposited at the center of this sample. The assembly was then heated in an oven at 37°C. Tests were then carried out to determine whether the film was permeable. (France)

58971 ATOMIC IRRADIATOR HAVING MEANS FOR ROTATING SAMPLES FOR UNIFORM EXPOSURE. Packin, Milton; Seid, Bernard (to Radiation Machinery Corp.). U. S. Patent 3,683,181. 8 Aug 1972. Filed 16 Oct 1967.

A thick-walled housing of radioactive absorbing material is described which has an enlarged cavity containing a solid movable block. A radiation source compartment is centrally disposed within the housing and immediately adjacent to the block. A radiation compartment is disposed within the block which can be moved into and out of alignment with the radioactive source. This compartment can also be moved into and out of alignment with an exterior access opening through the housing so that articles can be placed within the radiation compartment and subsequently moved to the interior of the housing and into alignment with the radiation source. The compartment has a movable turntable therein which permits the article to be uniformly exposed on all sides to the radiation source. (Official Gazette)

58972 WEAR OF PISTON RINGS OF A GASOLINE ENGINE. Furuhama, Shoichi (Musashi Inst. of Tech., Tokyo); Akishino, Katsuo. Junkatsu; 16: No. 12, 867-76(Dec 1971). (In Japanese).

A 74 × 75 mm, monocylinder test engine was used. Top rings made only of cast iron and with chromium plated on all the surfaces, outer surfaces as well as side surfaces, were irradiated in the JRR-2, a 10 MW research reactor for 290 h. The wear of the iron and chromium in these rings could then be measured separately and precisely by the radioisotope method. In experiments the following points were considered: rotation at a high speed, high load, corrosive wear, low-temperature dust in intake air, knocking by low octane fuels, and early spark timing. These experiments revealed the effects of the unusual wear on the outer surface and side surfaces and the materials of cast iron and chromium plating. Furthermore, they contributed to the elucidation of the mechanisms of unusual piston ring wear. (auth) (Japan)

LIFE SCIENCES

58973 EFFECTS OF LOW DOSES OF IONIZING RADIATION. Shiragai, A. (National Inst. of Radiological Sciences, Chiba, Japan). Phys. Med. Biol.; 17: No. 1, 94-5(Jan 1972).

A mathematical solution, based on the target theory, is derived for the survival curves for low and high LET radiation. The expressions support the experimental data of Rossi, deriving the RBE at low doses. The results suggest that inactivation by low LET radiation occurs predominantly by two particle processes down to the lowest doses. (UK)

Radiation Effects on Biochemicals (External Source)

Refer also to abstracts 58618, 58990, 58992, and 58993.

58974 CLEAVAGE OF TRITIUM FROM SOLID, GAMMA-IRRADIATED URACIL-5-T AND URACIL-6-T. Merwitz, O. (Kernforschungsanlage, Juelich, Ger.). Biophysik; 8: No. 4, 310-15(1972). (In German).

In continuation of previous studies specifying the dose-effect curves for the radiation-induced tritium cleavage from thymine-(methyl-T) and thymine-6-T (Merwitz, 1971) and from adenine-2-T and adenine-8-T (Merwitz, 1972), tritium cleavage from uracil-5-T and uracil-6-T was investigated. The comparison of dose-effect curves shows that the radioresistance is increased in the order thymine, uracil, and adenine, respectively. The graphically determined threshold doses for the cleavage of tritium are in the range of 10^4 rad for uracil-5-T and of $2 \cdot 10^4$ rad for uracil-6-T. The correlation between cleavage of hydrogen and formation of hydrogen-addition radicals was discussed. (auth)

58975 INTERACTION OF RADIATION ENERGY WITH NUCLEIC ACIDS. Latarjet, Raymond (Institut du Radium, Paris). Curr. Top. Radiat. Res. Quart.; 8: No. 1, 1-38(Jul 1972).

This article attempts to give a classical review of what may be considered as the central problem of radiobiology. In particular, problems of electronic excitation and radical formation subsequent to energy absorption are discussed for the irradiation of nucleic acids both in the dry state and in an aqueous medium. The resulting biochemical reactions are described, and their respective contributions to the origin of genetic radiolesions are discussed. Natural or induced repair mechanisms for these chemical alterations are also described and discussed in relation to the restoration of the biological functions. Emphasis was given to presenting the facts and notions acquired rather than to developing recent advances. (auth)

58976 ENZYMATIC REPAIR OF RADIATION-INDUCED STRAND BREAKAGE IN CELLULAR DNA AND ITS CHEMICAL INHIBITION. Kaplan, Henry S. (Stanford Univ., Calif.). Radiology; 105: No. 1, 121-6(Oct 1972).

There is now abundant evidence that the principal lethal effect of ionizing radiations involves alteration of the DNA of the cell. Sophisticated biophysical techniques have facilitated the quantitative estimation of single- and double-strand breaks induced in cellular DNA by graded radiation doses, while chemical methods have permitted the detection of other types of damage. Studies of bacterial mutants have established the existence of several different enzymatic repair systems and identified a new class of chemical radiosensitizers that inhibit such repair processes. Such agents may be useful in characterizing these repair processes further and in modifying radiation sensitivity during radiotherapy. (auth)

58977 RADIATION-SENSITIVITY OF MITOSIS AND THE SYNTHESIS OF THYMIDINE KINASE IN PHYSARUM POLYCEPHALUM: A COMPARISON TO THE SENSITIVITY TO ACTINOMYCIN D AND CYCLOHEXIMIDE. Oleinick, Nancy L. (Case Western Reserve Univ., Cleveland). Contract W-31-109-eng-78. Radiat. Res.; 51: No. 3, 638-53(Sep 1972). (COO-78-249).

The periodic synthesis of thymidine kinase has been studied in the naturally synchronous acellular slime mold, Physarum polycephalum. Density-shift experiments indicate that the peak of enzyme activity which appears 30–45 min past metaphase represents actual synthesis of the enzyme protein. Synthesis can be prevented by prior exposure of the plasmodium to actinomycin D, cycloheximide, or γ-radiation. For each of these three agents, time periods exist in the mitotic cycle during which mitosis and the synthesis of thymidine kinase become insensitive to that agent. These time periods are not coincident: for enzyme synthesis the transition period for actinomycin D occurs up to 15 min earlier in the mitotic cycle than the period for 9500 R of γ-radiation which, in turn, occurs 5–15 min earlier than that for cycloheximide. It is therefore proposed that γ-radiation interferes with a metabolic event which takes place after actinomycin D-sensitive transcription but prior to the completion of cycloheximide-sensitive translation. (auth)

58978 ELECTRON PARAMAGNETIC RESONANCE STUDY OF IRRADIATED TOOTH ENAMEL. Cevc, P.; Schara, M.; Ravnik, C. (Univ. of Ljubljana, Yugoslavia). Radiat. Res.; 51: No. 3, 581-9(Sep 1972).

In the inorganic hydroxyapatite matrix of tooth enamel a new stable radiation damage CO_3^{3-} has been found with $g_\perp = 2.0036$ and $g_{||} = 1.9983$. The origin of the H atom centers is bound to the hydroxyapatite OH^- ions. Orientation of the microcrystallites as well as the role of water diffusion throughout the enamel structure has been discussed. (auth)

58979 GENETIC TRANSFORMATION OF T4 PHAGE. XV. FUNCTIONING OF EARLY GENES OF INTACT AND DAMAGED DONOR DNA OF T4 PHAGE IN ESCHERICHIA COLI LYSOZYME SPHEROPLASTS. Fonshtein, L. M.; Mnatsakanyan, G. G. (Inst. of General Genetics, Moscow). Genetika; 8: No. 8, 126-33(Aug 1972). (In Russian).

The possibility of the functioning of several early genes of phage donor DNA (genes 32, 33, 41, 42) was demonstrated. The criterion of the functional activity of donor DNA genes was a complementary effect, which was registered according to the level of the transformant yield in the conditions nonpermissive for the recipient phage reproduction. This effect depended on the state of the secondary structure of donor DNA and was significantly higher for the native DNA. Fragmentation and uv irradiation of DNA caused a sharp decrease of its activity in conditions in which functioning of donor DNA genes was necessary for the transformant yield. (auth)

58980 DIFFERENTIAL EFFECT OF IONIZING RADIATION ON THE SYNTHESIS OF DEOXYRIBONUCLEIC ACID IN ASCITES CELLS IN STATIONARY AND MULTIPLYING PHASES. Watkins, D. K. (Hammersmith Hospital, London). Radiat. Res.; 51: No. 3, 615-30(Sep 1972).

The rates of incorporation of [2-^{14}C]thymidine into growing attached cells, and stationary suspensions of cells, were compared after electron irradiation in air. Incorporation into both the pool and the cellular DNA was reduced to a greater extent in the stationary cells than in the plated cells. Depression in the suspensions was accompanied by a comparative increase in pool size at the lower doses responsible for the sensitive component of the dose-effect curve for DNA synthesis. Following irradiation, prolonged exposure to thymidine led to a greater depression of its incorporation. When thymidine concentrations were reduced ($\lesssim 10$ μM) an enhanced effect of radiation was observed which could not be accounted for by an observed equivalent expansion in the endogenous-thymidine pool. The hypothesis is advanced that radiation damage to the cell membrane was responsible for this effect, and that such a lesion could lead to the postirradiation differences observed in the attached and the suspended cells. (auth)

58981 X-RAY-INDUCED SINGLE-STRAND BREAKS IN INTRACELLULAR DNA IN THE PRESENCE OF N-OXYLS. Johansen, Ivar (Forsvarets Forskningsinstitutt, Kjeller, Norway). Int. J. Radiat. Biol.; 22: No. 2, 179-82(Aug 1972).

Sedimentation profiles of superinfecting ^{3}H-labelled phage λ DNA in alkaline sucrose gradients were studied after x-irradiation over a dose range of 0 to 40 Krads, and in the presence of 3 N-oxyls. The results showed that norpseudopelletierine N-oxyl (NPPN), triacetoeamine N-oxyl (TAN), and tetramethylpiperidinol N-oxyl (TMPN), at concentrations of up to 1×10^{-3} M did not increase the yield of x-ray induced DNA single strand breaks under physiological conditions. At higher concentrations they tended to protect. (UK)

58982 BIOLOGICAL DAMAGE FROM INTRANUCLEAR TRITIUM: DNA STRAND BREAKS AND THEIR REPAIR. Cleaver, J. E. (Univ. of California, San Francisco); Thomas, G. H.; Burki, H. J. Science; 177: No. 4053, 996-8(15 Sep 1972).

Isotopic decay in tritiated thymidine in the DNA of frozen Chinese hamster cells causes breaks in DNA strands to accumulate at a rate of 2.1 breaks per decay. After DNA is thawed the tritium-induced breaks repair rapidly with a half-time of 15 minutes at 37°C. In comparison to breakage by x-rays, the efficiency of DNA strand breakage by tritium is equivalent to 0.48 rad per decay. This dose per decay is close to that predicted by simple dosimetric considerations (0.38 rad per decay) for irradiation by the β particles from tritium. (auth)

58983 DNA CHAIN ELONGATION AND JOINING IN NORMAL HUMAN AND XERODERMA PIGMENTOSUM CELLS AFTER ULTRAVIOLET IRRADIATION. **Buhl, Steven N.; Stillman, R. M.; Setlow, R. B.; Regan, James D. (Univ. of Tennessee, Oak Ridge). Biophys. J.; 12: No. 9, 1183-91(Sep 1972).**

DNA synthesized in cultured human cells after ultraviolet (uv) irradiation is made in segments of lower molecular weight than in unirradiated cells. Within several hours after irradiation these smaller units are both elongated and joined together. This repair process has been observed in normal human fibroblasts, HeLa cells, and fibroblasts derived from three types of xeroderma pigmentosum patients, uncomplicated with respect to neurological problems, complicated (de Sanctis-Cacchione syndrome), and one with the clinical symptoms of xeroderma pigmentosum but with normal repair replication. The ability of human cells to elongate and to join DNA strands despite the presence of pyrimidine dimers enables them to divide without excising the dimers present in their DNA. It may be this mechanism which enables xeroderma pigmentosum cells to tolerate small doses of uv radiation. (auth)

Radiation Effects on Cells (External Source)

Refer also to abstracts 58982, 58983, and 59089.

58984 INDUCTION OF GENE MUTATIONS IN CULTURED MAMMALIAN CELLS AS A MODEL FOR ESTIMATION OF RADIATION GENETIC HAZARD. **Kuznetsova, N. N.; Khalizev, A. E. (Kurchatov Inst. of Atomic Energy, Moscow). Genetika; 8: No. 7, 65-70(Jul 1972). (In Russian).**

The induction of mutations to 8-azaguanine resistance (10, 20 and 30 μg/ml) in cultured chinese hamster cells was investigated. Cells were exposed to acute (250–600 R) and chronic irradiation for 9–12 days (the total dose was 190–260 R). The average values of induction to 8-azaguanine resistance (30 and 10 μg/ml) after acute irradiation (600 R) were $2.8 \cdot 10^{-7}$ and $8.0 \cdot 10^{-17}$ mutations per 1 locus per 1 roentgen respectively. No induction of mutations after chronic irradiation was observed. This seems to be caused by repair of premutational DNA lesions. The gene mutation rate in somatic cells in vitro was compared to that in spermatogonia in vivo after irradiation with different dose rates. It is suggested that mammalian cells in vitro may serve as an adequate model for estimation of radiation genetic hazard. (auth)

58985 CHROMOSOME ABERRATIONS OF HUMAN LYMPHOCYTES AFTER X-IRRADIATION IN VITRO. I. QUALITATIVE AND QUANTITATIVE ASPECTS OF DOSE-RESPONSE CURVES. **Schmid, E.; Bauchinger, M.; Hug, O. (Univ., Munich). Mutat. Res.; 16: No. 3, 307-17(Nov 1972). (In German).**

Human peripheral lymphocytes were irradiated with different doses of 220 kV x rays. The frequency of different aberration types was determined and dose-response curves were constructed. The data were fitted by least squares regression analysis to a power law and a linear quadratic model, as well as to the special cases of a pure linear and a D^2 relation. If in a cell an exchange and several acentrics could be observed, either two fragments (assuming an incomplete exchange) or only one fragment (complete exchange) were assigned to the exchange. This results in two groups of acentric fragments ac_2 and ac_1 respectively. The dicentric, dicentric + centric ring, and different acentric data gave the best fit to the linear quadratic model $Y = c + \alpha D + \beta D^2$. The data for atypical translocation chromosomes are an exception and best fit a D^2 relation. With regard to the aspect of biological dosimetry a systematic investigation and interpretation of dose–effect relationships in human peripheral lymphocytes is given. Possible reasons for discrepancies between results of different laboratories, e.g. the varying statistical and mathematical treatment of experimental data, are discussed. (auth)

58986 EXPRESSION TIME AND SPONTANEOUS MUTABILITY IN THE ESTIMATION OF INDUCED MUTATION FREQUENCY FOLLOWING TREATMENT OF CHINESE HAMSTER CELLS BY ULTRAVIOLET LIGHT. **Arlett, C. F.; Harcourt, Susan A. (Univ. of Sussex, Brighton, Eng.). Mutat. Res.; 16: No. 3, 301-6(Nov 1972).**

Ultraviolet light has a dose-dependent effect on the optimum expression time for 8-azaguanine-resistant mutants, thus variable expression times are a prerequisite for any mutation experiment. When the induced mutation frequencies are taken as the difference between the optimum frequency for each dose and the optimum frequency for the control unirradiated population, the dose-response curve obtained is biphasic or cumulative, with more mutants being produced per unit of dose at high than at low doses. The spontaneous mutation frequencies observed in this system vary over a wide range and are correlated with induced frequencies in such a way that in experiments with high spontaneous frequencies high induced frequencies are also observed. (auth)

58987 PLATEAU-PHASE CULTURES OF MAMMALIAN CELLS: AN IN VITRO MODEL FOR HUMAN CANCER. **Hahn, George M. (Stanford Univ., Palo Alto, Calif.); Little, John B. Curr. Top. Radiat. Res. Quart.; 8: No. 1, 39-83(Jul 1972).**

Cells in tissue culture limit their growth rate until, at saturation density, the cell number stabilizes. Such plateau-phase cultures appear to have many properties in common with tumor cell populations. Data from two cell lines (Chinese hamster HA; human liver LICH) are used to illustrate common measurable kinetic variables that change with increasing cell number: cell-number dependent cell-cycle parameters including an increase in the duration of the S phase; reduced growth fraction; and the appearance of cell loss. Related to the kinetic changes are changes in radiation sensitivity and repair capacity. Two repair phenomena are measurable in some plateau phase cultures: repair of sublethal and potentially lethal lesions. Operationally, the first is seen in terms of changes in the shoulder of x-ray survival curves; the second repair is dose dependent and can be expressed as a change in slope. Repair of potentially lethal damage, which is difficult to demonstrate in actively growing cells, probably occurs in most plateau-phase cultures and in tumors. It probably is of importance in radiotherapy of malignant tumors. The ease of studying and quantitating the amount of this repair occurring in plateau cultures illustrates the usefulness of the system as an in vitro cancer model. (auth)

58988 FURTHER STUDIES ON RADIATION-INDUCED INTERPHASE DEATH OF CULTURED MAMMALIAN CELLS. **Goldstein, R.; Oakada, S. (Univ. of Rochester, N. Y.). Contract AT(30-1)-1286. Radiat. Res.; 51: No. 3, 685-95(Sep 1972). (UR-3490-13).**

Interphase death of cells in the stationary phase is compared with that seen in irradiated cells in the exponential phase of growth. Cells in the stationary phase seem slightly more radioresistant. Death of cells in stationary phase is accelerated by presence of DNP or puromycin while irradiated exponential growth phase cells show accelerated cell death only with dinitrophenol. Death of stationary phase cells irradiated with relatively low doses (0.5 and 5 rads) is unchanged from spontaneous death of nonirradiated stationary phase cells while exponential phase cells die in a two-step fashion after irradiation at these doses. Irradiated cells which were cooled to 26°C did not die until rewarmed to 37°C. Decreased serum concentration in the growth medium of stationary phase cells slowed the death process. These findings suggest over-all disorganization of cellular structures as an explanation of radiation-induced interphase death. (auth)

58989 EFFECT OF CAFFEINE ON DYNAMICS OF CHROMOSOMAL MUTABILITY IN PERMANENTLY REPRODUCED CULTURE OF CHINESE HAMSTER CELLS INDUCED BY γ-IRRADIATION AT THE G_2 STAGE. **Shalumashvili, M. A. (Inst. of General Genetics, Moscow). Genetika; 8: No. 8, 73-8(Aug 1972). (In Russian).**

Cytogenetic study of the effect of caffeine on dynamics of chromosome mutability in Chinese hamster cells exposed to γ-irradiation at the stage G_2 revealed that caffeine had a sensitizing and modifying effect on the spectra of chromosome aberrations, irrespective of the time of fixation. The data obtained afford the evidence in favor of the assumption that the effect of caffeine on cells irradiated with γ rays is connected with the process taking place in cells at the time of the onset of potential changes and affecting the destiny of these changes. (auth)

58990 LIPOPEROXIDATION OF X-RAY IRRADIATED KB CELLS. **Deby, C.; Benmiloud, M.; Magotteaux, G. (Univ., Liege). Compt. Rend. Soc. Biol.; 165: No. 11, 2219-24(1971). (In French).**

Cellular cultures irradiated with x rays present small quantities of lipidic peroxides. The peroxidation process occurs more rapidly if the culture medium is artificially enriched with nonsaturated fatty acids (ethyl linoleate). Metallic ions (e.g., Fe^{2+}) can also be introduced. Determinations carried out with cultures irradiated with 1000 R demonstrated that an increase in the intercellular peroxidation rate occurred during 6 hrs after the irradiation. Such determinations emphasize the importance of the action of catalysts such as Fe^{2+}. (France)

Radiation Effects on Microorganisms (External Source)

Refer also to abstracts 58955, 58968—58970, 58976, and 59089.

58991 (AECL—4272) BIOLOGY AND HEALTH PHYSICS DIVISION PROGRESS REPORT, APRIL 1—JUNE 30, 1972. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1972. 67p. (PR-B-94). Dep. NTIS (U. S. Sales Only). AECL $1.50.

Separate abstracts were prepared for four sections of this report. (H.L.W.)

For abstracts of individual sections see: 58783, 58829, 58992, and 59063.

58992 (AECL—4272, pp 7-23) BIOLOGY. Marko, A. M. Sep 1972.

Research in biochemistry and molecular biology included the following projects: comparison of RNA molecules in animal cells by oligonucleotide analysis; study of rapidly sedimenting, heterogeneous RNA in animal and yeast cells; search for genes corresponding to polyA sequences found in messenger and heterogeneous nuclear RNA; role of cell membranes in radioinduced degradation of DNA in Escherichia coli; effects of radiosensitizing agents on E. coli; radiation protection of rat thymus cells; induction of leukemia in rats; nucleases of Micrococcus radiodurans; and repair of radiation damage in M. radiodurans and Schizosaccharomyces pombe; Research in genetics, development and population studies included the following projects: genetic control of radiosensitivity in S. pombe; replicating instabilities in S. pombe; liquid holding recovery and spontaneous cell death in the normal and radiosensitive strains of S. pombe; the effect of dark repair inhibitors on growth of irradiated S. pombe cells; superinfection exclusion by bacteriophage T4; polyacrylamide gel electrophoresis of phage T4; radiation genetics of Dahlbominus; radiation injury in Rhodnius; and radiation studies on biting flies. (H.L.W.)

58993 (COO—3482-9) RADIATION RESPONSE OF BACTERIAL RADIATION REPAIR SYSTEMS. Progress Report, January 1—December 31, 1972. Bruce, Alan K. (State Univ. of New York, Albany. Research Foundation). 1972. Contract AT(11-1)-3482. 39p. Dep. NTIS.

Responses of Micrococcus radiodurans (wild-type) and a sensitive mutant (UV17) were studied after uv and x irradiation. After uv exposure, dimer excision is slower, more single strand breaks accumulate, and a greater delay in DNA synthesis is seen in the UV17 strain. For both uv and x-ray exposure, a greater amount of DNA degradation occurs in UV17. After x rays, both strains can repair single strand breaks at 4°C in buffer and under growth conditions resume synthesis of DNA before all breaks are removed. Lysates of both strains demonstrate equal DNA polymerizing activity but UV17 shows greater nuclease activity. X-ray exposure to doses of 400 kR shows little effect on the ability of either strain to excise dimers, but higher doses apparently do. Similar effects are found on dimer excision from transforming DNA by the wild-type strain. X-ray induced DNA degradation in the presence or absence of T7 phage is found to be influenced by genetic loci in Escherichia coli as is their ability to be protected by a dose-modifying agent. No relationship, however, is apparent between degradation, survival, and degree of protection. A correlation between energy coupling and radiation response is found in a series of respiratory deficient mutants of yeast and may be true for three strains of bacteria tested. Radiation response is apparently not determined by radiation damage to the excision enzyme, at least in M. radiodurans, but energy coupling may play a role. (auth)

58994 COMPARATIVE EFFICIENCY OF γ-RAYS WITH DIFFERENT DOSE CAPACITY IN SELECTION OF LINCOMYCIN-PRODUCING ORGANISM. Lapchinskaya, O. A.; Pogozheva, V. V. (Inst. for New Antibiotics, Moscow). Antibiotiki; 16: No. 6, 534-8 (Jun 1971). (In Russian).

The effect of γ-rays of two different dose rates, i.e., 195 and 3600 R/min on mutation variation in a number of strains of the lincomycin-producing organism, was studied. An evident mutagenic effect of irradiation in a dose of 195 R/min was found. The experiments showed a possibility of repeated use of γ-rays with low dose rates in selection of the lincomycin-producing organism. (auth)

58995 MUTATION TO PROTOTROPHY IN ESCHERICHIA COLI K-12: EFFECT OF BROTH ON UV-INDUCED MUTATION IN STRAIN AB1157 AND FOUR EXCISION-DEFICIENT MUTANTS. Green, Michael H. L.; Rothwell, M. Anne; Bridges, Bryn A. (Univ. of Sussex, Brighton, Eng.). Mutat. Res.; 16: No. 3, 225-34(Nov 1972).

We have studied uv-induced reversion to His^+ in the K-12 strain AB1157 and four of its uvr (excision-deficient) derivatives. The presence of a small amount of broth in the selective agar increased uv-induced mutation substantially in strains AB1157, AB1885 uvrB, AB1884 uvrC, and PAM579 uvrB, but not in strain AB1886 uvrA. When strains AB1157 and AB1185 uvrB were uv-irradiated and incubated in minimal growth medium the effect of broth on mutation was lost much more rapidly in strain AB1157. Therefore, although broth can affect uv-induced mutation in some other way than by influencing excision repair, possibly by altering the accuracy of post-replication repair, the kinetics of the loss of the broth effect seem to depend on excision repair. This may be because dimers persist and undergo post-replication repair over a much longer period in a uvr than in a uvr^+ strain. We also suggest an explanation for the variability in the broth effect between uvr strains. A minority of spontaneous His^+ revertants in strains AB1157 and AB1885 uvrB showed ochre-suppressing activity. The majority of uv-induced His^+ revertants in strain AB1157 showed ochre-suppressing activity but no uv-induced His^+ revertants in AB1885 did so. In two uv-induced ochre-suppressing His^+ revertants of strain AB1157, the His^+ phenotype appeared to result from the ochre suppressor. One revertant appeared to be an amber supE to ochre supB interconversion, the other a de novo ochre supL mutant. (auth)

58996 ULTRAVIOLET MUTAGENESIS IN REPAIR-DEFICIENT DERIVATIVES OF ESCHERICHIA COLI B/r: uvrA recB AND uvrA recC STRAINS. Witkin, Evelyn M. (Rutgers—The State Univ., New Brunswick, N. J.). Mutat. Res.; 16: No. 3, 235-42(Nov 1972).

Ultraviolet mutability of uvrA derivatives of E. coli B/r carrying recB or recC mutations was compared with that of otherwise isogenic Rec^+ strains. The frequency of uv-induced mutations per survivor from Try^- to Try^+ and from Str-s to Str-r, as well as the absolute yields of these mutations, was significantly lower in the recB and recC strains than in Rec^+ at the same uv doses. The results support the hypothesis that uv-induced mutations in these strains originate as errors associated with the occurrence of $recA^+$-dependent post-replication repair of gaps in DNA opposite pyrimidine dimers, and that maximal uv mutability requires participation of the recB—recC nuclease in this repair process. The reduced mutability of recB and recC strains may reflect a change in the accuracy of post-replication repair, such that fewer errors are made per gap repaired than in Rec^+ strains. Alternatively, the accuracy of post-replication repair may be unchanged, and the reduced uv mutability may result from the reduced tolerance of recB and recC strains for unexcised pyrimidine dimers, with consequent selective survival of a fraction of the irradiated population containing fewer dimers per cell, compared to the surviving fraction in Rec^+ at the same uv dose. Data obtained at very low doses of uv indicate that reduced dimer tolerance alone cannot account for the observed reduction in uv mutability of recB and recC strains, unless it is assumed that dimer tolerance is not equally reduced in different regions of the genome. (auth)

58997 EFFECT OF PHOSPHATE BUFFER ON THE DIFFERENTIAL RESPONSE OF TWO GENES IN NEUROSPORA CRASSA TO UV. Allison, M. J. (Scottish Plant Breeding Station, Pentlandfield). Mutat. Res.; 16: No. 3, 243-8(Nov 1972).

Conidia of an adenine- and inositol-requiring strain of Neurospora crassa were exposed to uv in water or in phosphate buffer. In buffer the frequency of inositol reversions was consistently higher than in water while the frequency of adenine reversions varied slightly and inconsistently. As a result, the mean ratio of inositol to adenine reversions increased from 1.6 in water to 2.6 in buffer. A combination of buffer treatment with photorepair increased this ratio even more, to between 5 and 6. The buffer effect is not due to pH and can probably be attributed to the phosphate salts in the buffer. These have to be present during treatment; given after treatment they tend to reduce the frequency of inositol reversions. The question whether this is a pointer to the mechanism of the buffer effect is discussed. (auth)

58998 UV-INDUCED REPLICATING INSTABILITY IN FISSION YEAST SCHIZOSACCHAROMYCES POMBE. Dubinin,

N. P.; Kurennaya, O. N.; Kurlapova, L. D.; Tarasov, V. A. (Inst. of General Genetics, Moscow). Mutat. Res.; 16: No. 3, 249-64(Nov 1972).

A system of forward mutations was used to study uv-induced replicating instability in the fission yeast Schizosaccharomyces pombe at five adenine-dependent loci that precede the ad-7 locus in the adenine synthetic pathway. Mutations resulting from realization of replicating instabilities were observed in 270 cell generations investigated. Realization of replicating instabilities may lead to both forward and reverse mutations, the frequency of forward being much higher than that of reverse or suppressor mutations. In strains of normal and high uv sensitivity the frequencies of secondary mosaicism in the progeny of primary mosaics were 5.5 and 0.39%, respectively. In the strain with normal uv sensitivity the presence of caffeine in the plating medium of primary mosaics decreased the level of secondary mosaicism from 12.8 to 0.14%. Cells from red colonies taken from the caffeine-containing medium yielded further mosaics at a rate of 34.3% in the absence of caffeine and of 0.6% in its presence. (auth)

58999 RECOVERY PHENOMENA IN YEAST. IV. ROLE OF PROTEIN SYNTHESIS IN LIQUID HOLDING RECOVERY. Kuznetsova, O. B.; Arman, I. P. (Kurchatov Inst. of Atomic Energy, Moscow). Genetika; 8: No. 7, 124-32(Jul 1972). (In Russian).

Lethal and recombination effects of uv-light may be significantly reduced by prolonged delaying of the first postirradiation budding (LHR) (incubation in buffer after uv-irradiation at 30°C for 24 hours). The necessary condition for LH-recovery of genic effects induced by uv-irradiation in an active protein synthesis during all the period of postirradiation incubation in buffer. The process of LHR was blocked when actidion (cycloheximide), an inhibitor of protein synthesis in yeast, was added to the cell suspension. The period of maximal rate of LHR was preceded by a latent period (4 to 6 hours), which duration depended on the genotype of the strain used. It is possible that the beginning of LHR was determined by a definite level of necessary protein (s). The effectivity of photoreactivation of lethal and mutagenic uv-lesions decreased during the first hours of postirradiation incubation of normal cells. The inhibition of protein synthesis did not affect this process. Data on the role of protein synthesis in LHR, together with the kinetics of LHR and removal of dimers indicated that LHR and dark repair (excision-resynthesis) took place independently. (auth).

59000 BACTERIOPHAGE OF BACILLUS SUBTILIS. Aziz'ekyan, R. R. Usp. Sovrem. Genet.; No. 4, 3-46(1972). (In Russian).

The biological and chemical characteristics of the phage of B. subtilis are reviewed, and the action of physical and chemical agents on the organism is discussed. Attention is turned briefly to the survival of the phage when exposed to uv light or when the host B. subtilis has been irradiated with uv. A study of lethal and mutagenic action by uv showed that the maximum effect on the phage is produced by the dose which destroys 30% of the host organisms. The article also deals with the subjects of transduction and transformation properties of nucleic acids, and some genetic aspects of the phage. (K.S.W.)

59001 STUDIES OF A SIMPLE LABORATORY MICROECOSYSTEM: EFFECTS OF STRESS. Ferens, M. Catherine; Beyers, Robert J. (Univ. of Georgia, Athens). Contract AT(38-1)-310. Ecology; 53: No. 4, 709-13(1972).

Inocula from an established microcosm were subjected to acute gamma radiation levels of 10^5 and 10^6 rads. Microcosms developed from these inocula were sampled through the 40-day successional period to determine effects of radiation stress. Chlorophyll "a" content, biomass, and community metabolism were measured. Significant reduction in chlorophyll "a" was found when each treatment level was compared to its control. Biomass was significantly reduced throughout succession for both treatment levels except for the last sample of 10^6 rad microcosms. Net productivity and nighttime respiration varied similarly and were significantly reduced during early succession at both treatment levels. Comparison of treatment effects revealed that the 10^5 rad level microcosms responded to the stress with a greater reduction in parameters measured than the 10^6. Explanation of this phenomenon may lie in inhibitory interactions among microcosm components at 10^5 rads. Elimination of certain species at 10^6 rads may have limited this interaction. The action of radiation at the community level was similar to that of other forms of stress in that radiation can differentially affect the organisms comprising a community and subsequently change community structure. The present study illustrates the idea that stress changes species dominants and succession. In addition, it emphasizes the significance of changes in interactions among community components when a community is stressed. (auth)

59002 EFFECT OF RADIOTHERAPY ON MICROORGANISMS IN ORAL CAVITY. Narita, Yoshihiro (Tokyo Univ.); Kunimoto, Norio; Suga, Masahiro; Washizu, Kunio. Nippon Kokoka Gakkai Zasshi; 19: No. 3, 457-62(Jul 1970). (In Japanese).

The presence of fungi in the oral cavity was examined in patients with oral tumors undergoing radiotherapy, and fungi were found in 56 of 91 cases examined. Strains detected numbered 56, including 48 of Candida albicans, 4 of other Candida species, and 4 of Torulopsis species. Acid production by Candida albicans isolated from the foci of patients undergoing radiotherapy was measured by titration with 0.1N NaOH, using phenolphthalein as an indicator, and sensitivity to antifungal agents by the cup method using Amphotericin B. Acid production was not markedly different from that in Candida albicans isolated from the normal oral cavity but sensitivity to antifungal agents was lower. Sensitivity to antibiotics was tested by the cup method and disc method with Candida albicans isolated from the oral cavity of patients in general, and Staphylococcus aureus and Bacillus pyocyaneus after irradiation. Sensitivity of Candida albicans to 10 μg of Amphotericin B became lower, and sensitivity of Staphylococcus aureus and Bacillus pyocyaneus became lower to penicillin, tetracyclin, chloramphenicol, and erythromycin. Sensitivity of Bacillus pyocyaneus decreased with increasing doses. Effect of irradiation on infectivity was examined by irradiation of mice with 250 or 500 R of x-ray, followed by intraperitoneal inoculation of Staphylococcus aureus, Bacillus pyocyaneus, or Candida albicans. Staphylococcus aureus failed to kill the non-irradiated mice but mortality increased with increasing dose, 2/10 by 250 R and 6/10 by 500 R. The same tendency was also observed with Bacillus pyocyaneus. However, irradiation of even 500 R failed to have any effect on infection with Candida albicans. (Japan)

59003 RADIOSENSITIVITY OF MICRO-ORGANISMS. Bonet-Maury, P. (Institut du Radium, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 93, 16-17(Jan 1972). (In French).

From Meeting on sterilization techniques of medical and surgical instruments by ionizing radiations; Lyon, France (18 Nov 1971). See CONF-711144.

The number of surviving microorganisms was determined during the course of an experiment involving the irradiation of a bacterial culture. This number usually decreases exponentially with the dose. The radiosensitivity is evaluated using the D_{10} factor (the dose corresponding to a 10% survival). Various investigations were carried out on Pseudomonas, Micrococcus radiodurans, Staphylococcus, and Bacillus subtilis. The degree of sterilization obtained depends on the dose, the radiosensitivity of the contaminating flora, and the nature of the medium. (France)

59004 SENSITIVITY OF STRAINS OF BACTERIA FREQUENTLY FOUND IN HOSPITAL ENVIRONMENTS TO γ RAYS. Fleurette, J.; Transy, J. (Hopital Cardiologique, Lyon). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 93, 29-34(Jan 1972). (In French).

From Meeting on sterilization techniques of medical and surgical instruments by ionizing radiations; Lyon, France (18 Nov 1971). See CONF-711144,

Three species of bacteria frequently isolated in hospital environments were studied: Staphylococcus aureus, Staphylococcus epidermidis, and Pseudomonas aeruginosa. The preparation of the suspensions to be irradiated is described; these suspensions were irradiated with doses between 10 and 125 krad. The irradiated samples and the reference sample were then examined numerically. The inactivation curve representing the logarithmic variation of the ratio between the number of bacteria surviving and the original number of bacteria present with the dose received is presented. The D_{10} factor is determined graphically. (France)

59005 VERIFICATION OF THE DEGREE OF STERILIZATION OF OBJECTS RADIOSTERILIZED IN THEIR PACKINGS. Bonet-Maury, P. (Institut du Radium, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 93, 35-8(Jan 1972). (In French).

From Meeting on sterilization techniques of medical and surgical instruments by ionizing radiations; Lyon, France (18 Nov 1971). See CONF-711144.

Two tests were developed to verify the degree of sterilization and contamination of objects having been radiosterilized in their package. In the first case, a nutritious liquid medium is injected (under sterile conditions) into the packing envelope. The hole made by the injection is sealed. The package is heated in an oven to 37°C and observations are made during 8 days. If the medium is still limpid, it is sampled (under sterile conditions) and then seeded with thioglycolate (aerobium and anaerobium), meat-liver (anaerobium), and Sabouraud (yeasts and mushrooms). In addition, these seeds are placed in the oven during 8 days; the seeds are examined daily. In the contamination test, the envelopes to be tested are contained in a bacteria (Pseudomonas) aerosol and subjected to pressure fluctuations. The contamination apparatus is described. (France)

59006 STERILIZATION OF HUMAN CARDIAC VALVES USING γ RADIATION. Fleurette, J. (Hopital Cardiologique, Lyon); Transy, J.; Mikaeloff, P.; Petiot, M. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 93, 70-9(Jan 1972). (In French).

From Meeting on sterilization techniques of medical and surgical instruments by ionizing radiations; Lyon, France (18 Nov 1971). See CONF-711144.

The organization of the collecting of cardiac valves and their subsequent sterilization with γ rays are described. The following subjects are considered: bacteriological studies performed in order to define the level of contamination presented by valves obtained without special precautions, the nature of the microbes isolated, the γ dose necessary, and the handling procedure after sterilization. Preliminary results on the histological examination of irradiated valves and the surgical procedures adopted are given. (France)

59007 UV IRRADIATION-INACTIVATED TISSUE CULTURE VACCINE AGAINST ECTHYMA CONTAGIOSUM. Sawhney, A. N.; Manolova, N. H.; Gagov, I. J. (Inst. of Microbiology, Sofia). Compt. Rend. Acad. Bulg. Sci.; 25: No. 4, 557-60(1972).

A tissue culture vaccine against ecthyma contagiosum of sheep was prepared using uv radiation-inactivated virus. Vaccination trials showed that the uv-irradiated tissue culture vaccines were superior to formalism-inactivated vaccines with respect to both establishment of immunity and duration of protection. (E.R.B.)

59008 ENDONUCLEOLYTIC ACTIVITY FROM MICROCOCCUS LUTEUS THAT ACTS ON γ-RAY-INDUCED DAMAGE IN PLASMID DNA OF ESCHERICHIA COLI MINICELLS. Paterson, M. C.; Setlow, R. B. (Univ. of Tennessee, Oak Ridge). Proc. Nat. Acad. Sci. U. S. A.; 69: No. 10, 2927-31(Oct 1972).

A partially purified extract from Micrococcus luteus contains endonucleolytic activity toward ultraviolet (uv)-irradiated deoxyribonucleic acid (DNA). We found that the same extract also acts on superhelical, covalently-closed circular λdv DNA isolated from γ-irradiated minicells of E. coli. The introduction of nicks in isolated covalently-closed circular DNA by an endonuclease in the extract results in relaxed circles, and these two circular DNA species are easily distinguishable by their sedimentation properties in alkaline sucrose. The frequency with which the endonuclease-susceptible lesions are produced in superhelical DNA is only marginally enhanced when ^{60}Co γ rays are administered to an aerobic rather than an anoxic minicell suspension. The ratio of endonuclease-sensitive defects to single-strand scissions, induced by γ irradiation in air, is about 1 : 3. The nuclease-sensitive lesions disappear from γ-irradiated minicells during incubation after radiation presumably as a consequence of excision repair. Since the addition of uv-irradiated calf-thymus DNA depresses the ability of the M. luteus extract to attack not only uv-damaged E. coli DNA (a known substrate for the so-called uv-specific endonuclease that catalyzes the initial single-strand incision adjacent to the structural defect) but, also λdv DNA injured by γ rays, we conclude that physicochemical alterations induced by both types of radiation are recognized by one and the same endonuclease. (auth)

59009 UV-X-RAY SYNERGISM IN ESCHERICHIA COLI B/r. I. INHIBITION BY THE INCORPORATION OF 5-BROMOURACIL AND BY PURINE STARVATION. Baptist, J. E.; Haynes, R. H. (Univ. of Kansas, Lawrence). Photochem. Photobiol.; 16: No. 5, 459-64(Nov 1972).

In Escherichia coli. B/r, both 5-bromouracil incorporation and purine starvation appeared to inhibit x-ray repair with doses up to 70 Krads, and nearly or completely abolish the uv-x-ray synergism normally seen. Since purine starvation had little or no effect on the sensitivity of cells to ultraviolet, it was argued that the inhibition of x-ray repair alone was sufficient to decrease or eliminate the uv-x-ray synergism. It was suggested that the synergism seen in E. coli B/r was probably due to the inhibition of x-ray repair by uv radiation. (auth)

59010 GENETIC STUDY OF ROUGHNESS IN THE YEASTS OF SACCHAROMYCES ELLIPSOIDEUS. Papalashvili, G. M.; Chuchulashvili, I. I. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR; 67: No. 3, 677-80(Sep 1972). (In Russian).

Four loci (rgh_1, rgh_2, rgh_3, rgh_4) for crinkle were identified in the breeding stocks of Saccharomyces ellipsoideus among uv-induced rough mutations. They are not interlinked. (auth)

59011 CORRELATION BEWEEN UNREPAIRED RADIATION-INDUCED DNA STRAND BREAKS AND MITOTIC DELAY IN PHYSARUM POLYCEPHALUM. Brewer, E. N.; Nygaard, O. F. (Case Western Reserve Univ., Cleveland). Nature (London) New Biol.; 239: No. 91, 108-10(27 Sep 1972).

Using alkaline sucrose density gradient sedimentation techniques, it was demonstrated that single and double strand breaks in DNA could be repaired in the multinucleated slime mould Physarum polycephalum, and that there seemed to be a correlation between the number of unrepaired strand breaks and the cell cycle dependent response to radiation. Gamma radiation was used at 40 Krads and 80 Krads. The number of unrepaired DNA strand breaks (both double and single) remaining 3 to 4 hr after irradiation was greatest after irradiation in early S, less for mid-S, and least or none in early G_2 phase. (UK)

Radiation Effects on Plants (External Source)

59012 ENVIRONMENTAL MODULATION OF PLANT RESPONSE TO NEUTRON IRRADIATION. Smith, H. H. (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot.; 12: No. 4, 229-37(Sep 1972).

Various environmental factors that influence response to irradiation in both wet and dry plant systems are reviewed in the light of literature available. The following conclusions are drawn: The oxygen effect, expressed quantitatively as the oxygen enhancement ratio (OER), is lower for neutrons (1.3 to 1.9) than for sparsely ionizing radiations. X and γ rays give OER's of 2.4 to 3.4 in wet systems and 10 to 15 in very dry seeds (2 to 3% water content). Water appears to regulate the degree to which radiation induced oxygen-sensitive sites or radicals interact with oxygen to produce radiobiological damage. The protective effect of hypoxia is less with neutrons than with x irradiation, due most probably to endogenous production of oxygen in high LET tracks. Control over mutagenic or other specific radiobiological responses may lie less in specific reactions with DNA than with cellular processes that precede or follow treatment, so that preferential recovery may take place. Examples are given of some environmental perturbations that show promise for altering response to neutron irradiation. (UK)

59013 ULTRAVIOLET RADIOSENSITIVITY OF OEDOGONIUM CARDIACUM CELLS AT VARIOUS STAGES OF THE CELL CYCLE. Parker, K. E.; Horsley, R. J. (Cancer Treatment and Research Foundation, Hamilton, Ont.). Radiat. Bot.; 12: No. 4, 239-48(Sep 1972).

The ultraviolet (uv) radiosensitivity as measured by the loss of reproductive capacity of synchronously growing Oedogonium cardiacum cells cultured under different environmental conditions was measured during the first generation cycle and compared with the results for ionizing radiation. Both radiosensitivity patterns were approximately the same in shape exhibiting a maximum resistance in the S period and a minimum in the G_2. Following x-radiation, D_0 and n values varied with age by a factor of 7 and 40 respectively. In contrast, following uv radiation D_0 varied by a factor of 2.5 and n remained essentially constant. A variation in the magnitude of the uv radiosensitivity was observed between cells cultured in inorganic medium bubbled with 3% CO_2 in air and illuminated with fluorescent lights and cells cultured in diphasic soil-water medium under natural illumination. At all stages of the cell cycle, cells collected from stock cultures grown in the more natural habitat were approximately twice as resistant. A seasonal variation in uv radiosensitivity was also observed in cells collected from this latter groups. (auth)

59014 BIOCHEMICAL AND CYTOLOGICAL STUDIES ON DEVELOPING COTYLEDONS OF PINUS PINEA FOLLOWING X-IRRADIATION OF DRY SEEDS. Roy, R. M.; Donini, B.; Brunori, A. (Comitato Nazionale per l'Energia Nucleare, Casaccia, Italy). Radiat. Bot.; 12: No. 4, 249-60(Sep 1972).

The cotyledons in dry seeds of Pinus pinea which were selected for this study consisted exclusively of G_1 cells. During germination of seeds, cells resume mitotic activity which stops before full cotyledon development. The quantity of DNA, RNA and protein in cotyledons and the incorporation of isotopically labeled precursors into these fractions were measured at various developmental stages during germination of control and irradiated seeds (15 kR, 250 kVp x-ray). Concurrently, cytological investigations were carried out on mitotic activity, labeling index and chromosome aberrations. In irradiated cotyledons, the onset of DNA synthesis and mitotic activity were delayed by approximately 2 days; reduced synthesis of DNA, RNA and protein was also detected in irradiated cotyledons. Whereas accumulation of DNA was reduced 25% by the end of the maturation period, cotyledon length was reduced by about 40%. This radiation effect on cell elongation was found to be associated with a pronounced depression of RNA and protein synthesis in irradiated cotyledons during the elongation phase of development. Both RNA and protein synthesis were initiated in control and irradiated cotyledons by the 3rd day of germination, but were not inhibited in irradiated cotyledons until the 7th to 9th day; only lysine incorporation into protein was reduced on the 5th day. In the discussion an attempt has been made to correlate cytological and morphological effects of radiation with the synthesis of DNA, RNA and protein at various stages of cotyledon development. (auth)

59015 BIOLOGICAL EFFECTIVENESS OF THE PRIMARY REACTIONS OF THERMAL NEUTRONS. 1. DAMAGE RATES AND EFFECTIVENESS OF THE CAPTURE REACTIONS OF THERMAL NEUTRONS IN CHLORELLA PYRENOIDOSA. Knoop, H.-U. (Kernforschungsanlage, Juelich, Ger.). Radiat. Bot.; 12: No. 4, 261-9(Sep 1972). (In German).

Unicellular green algae Chlorella pyrenoidosa were exposed to the radiation field of the thermal neutron irradiation facility BE-15 of the 5 MW swimming pool reactor FRJ-1. The damage rates of significant radiation reactions arising were measured individually. This was done for the $^{14}N(n,p)^{14}C$ and $^{10}B(n,\alpha)^{7}Li$ capture reactions by gradually substituting ^{15}N and ^{11}B, each with negligible thermal neutron capture cross-section, for the reacting nuclides. The share of ^{1}H-reactions and other capture reactions of thermal neutrons was assessed from the difference between damage to algae fed with $^{11}B^{15}N$ in the complete radiation field and those caused to algae with natural nutrition in the radiation field without thermal neutrons. By additionally simulating the reactor γ rays by 150 kV x rays of the same dose and dose efficiency, it was possible after all to ascertain the damage rate of the gamma radiation and of the elastic nuclear collisions of non-thermal neutrons. Specific cell number, wet and dry weight as well as colony-forming ability and mutation rate are chosen as different criteria of radiation damage. Within the fluency range used the fluency effect curves show an exponential course. Under these conditions, 42% of the total damage and 93% of the damage by thermal neutrons were caused by the $^{14}N(n,p)^{14}C$ reaction. All reliably measurable damage rates of the radiation reactions are independent of the criterion considered. Referred to the absorbed dose, the ^{14}N-capture reaction is about 2.5 times more effective than the very similar charged particles due to elastic nuclear collisions of the non-thermal neutrons. Both results indicate the role played by transmutation $^{14}N \rightarrow {}^{14}C$ + 43 keV in connection with ^{14}N-reaction. The damage criteria chosen seem to be based on the damage to merely one or very few cell structures of equal nitrogen content. (auth)

59016 RELATIVE BIOLOGICAL EFFECTIVENESS (RBE) OF 0.43-MeV NEUTRONS AND 250-kVp X-RAYS FOR SOMATIC ABERRATIONS IN TRADESCANTIA SUBACAULIS BUSH. Kappas, A.; Sparrow, A. H.; Nawrocky, M. M. (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot.; 12: No. 4, 271-81 (Sep 1972).

The RBE of 0.43-MeV monoenergetic neutrons and 250 kVp x-rays for somatic cell aberrations or mutations in the heterozygous Tradescantia subacaulis Bush (clone 4405) was determined and compared with known RBE values for similar end points in Tradescantia clone 02. Young influorescences were irradiated with 0.04 to 15 rad of 0.43 MeV neutrons and with 6.25 to 150 rad of 250 kVp x-rays. Stamen hairs were scored daily over the peak response period from day 11 to 15 postirradiation. Data were recorded for cell color changes from normal blue to pink, plum and colorless and for changes in cell size from normal to dwarf and giant. Dose-response curves based on 5-day mean numbers of aberrant events were plotted for the various end points and their natural slopes computed. The slopes of the dose-response curves for each aberrant cell type resulting from x irradiation were higher than +1 but in 5 out of 6 cases significantly less than +1 for neutron irradiation. RBE values increased with decreasing doses, at least over the dose range investigated. Maximum RBE values for plum, dwarf colorless, pink and giant were 124, 110, 99, 93 and 57 respectively. The RBE values were higher for color changes but lower for cell size aberrations in T. subacaulis than in clone 02. The reasons for these differences in RBE are not known. The possible dependence of RBE on interphase chromosome volume (ICV) is discussed. (auth)

59017 STRUCTURE AND CHEMICAL COMPOSITION OF COTTON FIBER GROWN FROM γ-IRRADIATED SEED. Marupov, R.; Zhbankov, R. G.; Ivanova, N. V.; Shishko, A. M. (Inst. of Chemistry, Stalinabad, USSR). Dokl. Akad. Nauk Tadzh. SSR; No. 7, 29-32(1972). (In Russian).

The structure and properties of fibers from several varieties of cotton and their mutants were investigated. The contents of ash, pentosans, resins, and waxes, and degree of polymerization were compared. A qualitative spectral analysis of 17 elements, infrared spectroscopy, and a deuterium-exchange study were made of fibers. Certain correlations were drawn between these data on cotton fibers and their vegetative properties. (K.S.W.)

59018 EFFECT OF HIGH-ALTITUDE UV RADIATION ON THE BIOSYNTHESIS OF AMINO ACIDS DURING PHOTOSYNTHESIS. Zrgashev, A.; Abdurakhmanova, Z. N. (Inst. of Physiology and Biochemistry of Plants, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 14: No. 12, 53-7(1971). (In Russian).

Pea leaves (Pisum sativum) from plants grown at an altitude of 2,500 meters were analyzed for 13 individual amino acids in order to determine the effect of the uv radiation on biosynthesis. Using ^{14}C as a tracer, it was demonstrated that high-altitude uv radiation inhibited the incorporation of ^{14}C in the amino acids and lowered the total level of free amino acids in the cell. Slower growth and development of the pea plants were noted under the mountainous conditions. (K.S.W.)

59019 INFLUENCE OF TEMPERATURE SHOCKS ON SEED FORMATION AFTER IRRADIATION OF POLLEN FROM TRADESCANTIA PALUDOSA. Dryanovska, O. A. (Dept. of Cytogenetics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 25: No. 5, 681-3(1972).

Pollen from diploid and tetraploid clones of Tradescantia poludosa was γ-irradiated at doses of from 1 to 50 kR at a dose rate of 2 kR min. Following exposure, some of the pollen was stored at 0°C for 1 to 34 days and some of the pollen was used immediately to pollinate flowers at 20 to 25°C. The following conclusions were drawn from the investigation: gamma irradiation overcame the incrossability between the diploid and tetraploid clones at doses of 1 to 5 kR; temperature shock had a restorative effect on haploid and diploid pollen at doses of 5 to 50 kR; and temperature shock increased fertility and overcame incrossability at doses of 10 to 50 kR. (E.R.B.)

59020 PLEIOTROPIC EFFECT OF CHLOROPHYLL MUTATION IN PEA. Gostimskii, S. A. (Moscow State Univ.). Genetika; 8: No. 7, 31-6(Jul 1972). (In Russian).

Investigation was made of a chlorophyll mutant line of pea obtained from seeds exposed to gamma-rays. When mutant plants were grown in sunlight, chlorophyll was destroyed and the mutant died within 2 to 3 weeks after germination. It was shown that the qualitative composition of carotenoid pigments in leaves of mutant and control plants was similar, but the amount of pigments in mutants was somewhat lower. Study of photosynthesis intensity in young seedlings failed to reveal any sharp difference between mutant and normal plants. Grafting of the mutant into normal green plants resulted in obtaining seeds from homozygous mutant plants. Grafting has also shown that the mutant has spoon-like stipules and an abnormal form of flower. The nature of the pleiotropic effect of this chlorophyll mutation is discussed. (auth)

59021 MODIFICATION OF FREQUENCY OF X-RAY-INDUCED STRUCTURAL MUTATIONS IN CELLS OF CREPIS CAPILLARIS BY AURANTIN. Generalova, M. V.; Demin, Yu. S. (Inst. of Developmental Biology, Moscow). Genetika; 8: No. 7, 47-54(Jul 1972). (In Russian).

The effect of aurantin at different concentrations on the frequency and spectrum of x-ray-induced chromosome aberrations in the meristem of Crepis capillaris was studied. It was shown that aurantin at the concentration of 10 mkg/ml for 0.5 hour did not change the frequency of aberrations and did not induce the mitotic delay. The aurantin treatment (10 and 50 mkg/ml) for one hour induced the modification of the aberration frequency. Aurantin seems to affect the system controlling the duration of the cell cycle, but not the repair system and the formation of structural mutations. The conclusion is drawn that the radiation does not initiate the functioning of the repair system. The correlation between the repair processes and mitotic crossing-over is discussed. (auth)

59022 BIOLOGICAL EFFECTS OF COMBINATION TREATMENTS WITH IONIZING RADIATION (X-RAYS) AND DIETHYL SULFATE (DES) IN BARLEY. Mohan Rao, P. K. (Univ. of Malaya, Kuala Lumpur, Malaysia). Mutat. Res.; 16: No. 3, 322-7(Nov 1972).

The effects of x radiation and pre- or post-exposure diethyl sulfate treatment on barley seeds were studied in relation to mutation frequency, chromosomal aberration frequency, seedling injury, and plant lethality. The two treatments were found to be additive with respect to their effects on mutation frequency and chromosomal aberration frequency, and synergistic with respect to their effects on seedling injury and plant lethality. No difference was observed between the pre-exposure and post-exposure diethyl sulfate treatments. (E.R.B.)

59023 INDUCED FLORAL TRANSFORMATIONS IN BARLEY. Sethi, G. S.; Gill, K. S. (Punjab Agricultural Univ., Ludhiana, India). Radiat. Bot.; 12: No. 4, 283-5(Sep 1972).

Dry seeds of Hordeum sativum Jess, cv C 164 were treated with EMS, ^{60}Co γ-rays, ^{32}P and ^{35}S. Five types of floral transformation were observed and each was controlled by a single recessive gene. It is pointed out that these transformations imply an interpretation of both phylogeny and ontogeny of flower, and may become of interest in understanding the process of differentiation. (auth)

59024 EFFECT OF GAMMA RADIATION ON THE DISINTEGRATION OF RESERVE GLOBULINS IN GERMINATING COTTON SEEDS. Ibragimov, A. P.; Yunuskhanov, Sh. (Inst. of Biochemistry, Tashkent). Uzb. Biol. Zh.; No. 2, 3-6(1972). (In Russian).

Moistened cotton seeds were allowed to swell for 24 hr and then irradiated with a ^{60}Co γ source at doses of 6, 10, and 25 R. After irradiation the seeds were allowed to germinate for various periods of time. Globulin fraction ratios and amino acid composition were determined in the cotton seedlings. Deterioration of reserve protein in the germinated seeds was inhibited by gamma radiation in the early phases of seed development and alterations in the biosynthesis of individual protein components were observed. (K.S.W.)

59025 EFFECT OF GAMMA RADIATION ON THE ULTRASTRUCTURE OF THE COTTON CELL NUCLEUS. Arslanova, S. V.; Nazirov, N. N. (Inst. of Experimental Plant Biology, Tashkent). Uzb. Biol. Zh.; No. 2, 7-9(1972). (In Russian).

A radiosensitive late-ripening variety and a radioresistant early-ripening variety of Gossypium hirsutum were irradiated with gamma radiation with doses of 10 R in order to determine the effect of the radiation on the biosynthesis of DNA and ATP. Formation of both DNA and ATP was strongly depressed; this effect was especially pronounced in the radiosensitive variety as the nuclear membrane was destroyed. (K.S.W.)

59026 RADIOINDUCED MUTANT LINES OF COTTON (G. HIRSUTUM). Musaev, D. A.; Almatov, A. S. (Tashkent State Univ.). Uzb. Biol. Zh.; No. 2, 49-53(1972). (In Russian).

A comparative study was made of the radioinduced cotton mutant (L-44) with its original strain (L-16) and with F$_1$ hybrids following irradiating samples with ^{60}Co gamma radiation at a dose of 25,000 R. Various characteristics of the vegetative organs were measured and tabulated for the three lines: length of main stem, internodal length, sympodium, the number of leaves, and their total area for one plant. (K.S.W.)

59027 EFFECT OF GAMMA RADIATION OF ^{137}Cs ON THE GERMINATION OF POLLEN AND THE GROWTH OF POLLEN TUBES OF A FEW SPECIES OF THE GENUS TULIPA. Ermakou, P. Z.; Kudrautsava, V. M. (Central Botanical Garden, Minsk). Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 4, 31-5(1972). (In Belorussian).

The effect of a wide range of gamma radiation (0.05 to 100 KR of ^{137}Cs-emitted radiation) on the pollen of Tulipa species was investigated. Small doses (0.05 to 5 KR) exhibit a stimulating effect on pollen development and on the growth of pollen tubes. Larger radiation doses (>10 KR) retarded these functions, noticeably modifying the form of the pollen tube, rendering it misshapen, and causing it to discharge its contents prematurely. (tr-auth)

59028 PERIDERM DEVELOPMENT AND RADIATION STABILITY OF RUSSET-FRUITED SPORTS OF APPLE. Pratt, Charlotte (New York State Agricultural Experiment Station, Geneva). Hort. Res.; 12: 5-12(1972).

The anatomical origin of periderm was studied in "Stark" apple and its russet-fruited sport, "Stark 287". The sporadic russet on the otherwise smooth-skinned fruits of "Stark" was initiated primarily in the hypodermis, but derivatives of the epidermis appeared to participate to some extent. In the russet-fruited sport the epidermal cells of the fruits divided periclinally and died in wide areas. Russet was initiated in the hypodermis during the first month after bloom. In young fruits of both cultivars, following the loss of functioning outer cells, russet developed through the activity of phellogen arising in the most superficial cells that were still capable of dividing. Dormant scions of "Stark" and its russet sport were treated with 0, 2,000, or 3,000 rads of gamma rays. One percent of the irradiated scions of "Stark" bore russet fruits of a different character, thought to be a new mutation. One percent of the nonirradiated and 4 to 8% of the irradiated scions of the russet sport produced nonrusset fruits like those of "Stark". Dormant, shortened, one-year-old, potted trees of a hitherto undescribed russet sport of "Golden Delicious" were exposed to 0 rads or to a graduated dose of 8,000 rads of gamma rays at the top of the stem and 2,000 rads at the base. All the trees later produced only russet fruits. These russet sports are hypothesized to be periclinal chimeras with a mutation for abnormal development of the fruit epidermis in the first one or more layers of the apical meristem and nonmutated tissue below. Such chimeral patterns show a low frequency of reversion of fruits both from nonirradiated and from irradiated buds. (auth)

59029 GENETIC PROCESSES IN POPULATIONS SUBJECTED TO CHRONIC IONIZING RADIATION. Dubinin, N. P.; Shevchenko, V. A.; Alekseenok, A. Ya.; Cherezhanova, L. V.; Tishchenko, E. M. Usp. Sovrem. Genet.; No. 4, 170-205(1972). (In Russian).

The genetic consequences of prolonged action of ionizing radiations on natural populations are reviewed. Reference to laboratory population studies is made only when a specific mechanism is best illustrated. Populations of Drosophila, Chlamydomonas, and Chlorella, and their radioresistant forms are discussed. The types of radiation include x rays, β radiation from ^{90}Sr + ^{90}Y, uv, and γ radiation. Chromosome damage in some plants by ^{90}Sr–^{90}Y β is tabulated (e.g., Plantago, Centaurea, Vicia, and Veronica). The comparative radiosensitivity and mutation processes of red voles and forest mice are discussed. (100 references) (K.S.W.)

59030 GAMMA-RAY TREATMENT OF VINE SEEDS. Zankov, Z. Gradinar. Lozar. Nauka; 2: No. 7, 77-87(1970). (In Bulgarian).

Shiroka melnishka loza and Uni blanc seeds, picked from freely blossoming vines, were treated. Prior to irradiation, part of the seeds was stratified for a period of 160 days and part of them was kept immersed in water for 5 days. The irradiation was conducted in a nuclear reactor operating with Uranium-235 and -238 at 31 R/sec irradiation intensity after the following scheme: (1) Control; (2) Treatments of 1, 2, 4, 6, 10, 15, and 20 kR. One hundred seeds in three replications per dose were treated. After irradiation, the seeds were immediately sown into the soil where their germinating capacity and the growth of the seedlings were observed. The test was laid in two successive years—1963 and 1964. Control Uni blanc seeds, immersed in water for 5 days showed 77.6% germinating capacity, those irradiated with 1 kR–75.8%, with 2 kR–73%, with 4 kR–82.3%, with 6 kR–74.0%, with 10 kR–69.6%, with 15 and 20 kR–0.0%. The germinating capacity of the stratified and irradiated seeds was 71.0, 76.6, 68.3, 36.3, 0.0, and 0.0%, respectively. The mean shoot length at the end of the first vegetation period of the same cultivar, by variants, was 41.3, 47.3, 61.0, 44.7, 64.3, and 55.7 cm, developed from the seeds immersed for 5 days in water. Some morphological modifications of the seedlings, developed from the irradiated seeds, were observed, manifested in fasciations, albinism, and the occurrence of a great number of lateral shoots. (INIS)

59031 EFFECT OF CHRONIC IRRADIATION WITH ^{90}Sr AND EXTERNAL γ-IRRADIATION ON CYTOGENETIC CHANGES OF SOME AGRICULTURAL CROPS. Kaplan, I. S.; Kaplan, A. A.; Aleksakhin, R. M.; Khvostova, V. V. (Moscow State Univ.). Genetika; 8: No. 8, 52-9(Aug 1972). (In Russian).

Cytogenetic effect of chronic external γ irradiation (in a gamma-field) and β irradiation with ^{90}Sr + ^{90}Y, incorporated into the soil, were studied on different agricultural crops (wheat, barley, pea, bean). The survival and height of plants in the conditions when the cumulative dose of external γ irradiation was 1720 to 3900 rad and the concentration of ^{90}Sr in a soil was 1 to 3.7 mC/m^2 were not affected but the increase in chromosome aberrations in meiosis was observed (mainly chromatid aberrations). When the plants were grown for 2 yrs on the soil containing ^{90}Sr, the frequency of chromosome aberrations in meiosis in 2nd year plants was decreased as compared with that of the 1st year plants. This fact was probably due to the formation of plant populations with increased radioresistance. Under chronic external γ irradiation, when cumulative doses were higher, the frequency of chromosome aberrations in meiosis in the 2nd year plants was increased. In some cases the efficiency of β irradiation with ^{90}Sr + ^{90}Y was higher than that of external γ irradiation (the frequency of chromosome aberrations in meiosis was used as a criterion). (auth)

59032 EFFECTS OF ^{60}Co RADIATION ON CARROT SEEDS. I. INVESTIGATIONS ABOUT GERMINATIVE FACULTY AND OBSERVATIONS OF GROWTH. Bancher, E.; Riederer, P.; Washuettl, J. (Technische Hochschule, Vienna). Oesterr. Bot. Z.; 119: No. 4-5, 432-41(1971). (In German).

After γ irradiation with 3 and 8 kilorads, respectively, carrot seeds showed a highly significant enhancement of germinative faculty in laboratory experiments; however, this effect could not be reproduced in field experiments. Injury of irradiated carrot seeds with diminution of germinative faculty occurred at doses of 20 kilorads, and higher in laboratory experiments; whereas, in field experiments a significant decrease was observed with doses as low as 11 kilorads. At doses of 100 kilorads, approximately 37% of all harvested carrots showed the beginning of a second sprouting. (tr-auth)

59033 ASSOCIATION BETWEEN RESISTANCE TO XANTHOMONAS ORYZAE AND MORPHOLOGICAL AND QUALITY CHARACTERS IN INDUCED MUTANTS OF INDICA AND JAPONICA VARIETIES OF RICE. Singh, C. B.; Rao, Y. P. (Indian Atomic Research Inst., New Delhi). Indian J. Genet. Plant Breed.; 31: No. 2, 369-73(Jul 1971).

Several induced mutants of IR-8 (indica variety) and Tainan-3 (japonica variety) rice were evaluated for resistance to bacterial blight, incited by Xanthomonas oryzae. Several leaf characters like rolled, narrow, dark green, and slow senescence were associated with resistance. No consistent association between disease reaction and amylose and protein content in the grain was found. (auth)

59034 INFLUENCE OF SEED HUSK ON RADIOSENSITIVITY IN RICE. Singh, C. B. (Atomic Energy Lab., New Delhi). Indian J. Genet. Plant Breed.; 31: No. 2, 233-6(Jul 1971).

Hulled and unhulled seeds of indica and japonica rice varieties were irradiated with 20 and 30 kR of gamma rays. The influence of husk on radiosensitivity was measured using different biological parameters like rate of germination and survival, shoot growth inhibition, pollen and spikelet sterility etc. The results suggest that there is a considerable increase in radiosensitivity of varieties with the hulled treatments. The differential radiosensitivity of indica and japonica sub-species appears to be due to differences in the physical and chemical nature of husk in addition to genetic factors. (auth)

59035 MUTATION FREQUENCY IN BARLEY FOLLOWING TREATMENT WITH EMS OR GAMMA RAYS AND POST-TREATMENT WITH GA. Minocha, J. L.; Saini, R. G. (Punjab Agricultural Univ., Ludhiana, India). Indian J. Genet. Plant Breed.; 31: No. 2, 223-7(Jul 1971).

Ethyl methanesulphonate- and gamma radiation-treated seeds of barley were soaked in distilled water or 1000 ppM gibberellic acid for 2 hrs to study the effect of the post-treatments on the chlorophyll mutation frequencies. Post-soaking in water resulted in reduction in mutation frequencies. Mutation frequencies following mutagen plus GA treatments were slightly more as compared to mutagen plus water treatments. Maximum mutation frequencies, however, were obtained when no post-treatment was given. (auth)

59036 SOME RADIATION INDUCED MUTANTS IN TITHONIA. Kaicker, U. S.; Swarup, Vishnu; Singh, Harpal (Indian Agricultural Research Inst., New Delhi). Indian J. Genet. Plant Breed.; 31: No. 2, 218-22(Jul 1971).

In Tithonia, it was possible to induce mutations by γ irradiation of seeds, giving rise to qualitative variations of a desirable nature, viz. change in color from orange red to yellow and striped types. However, the radiation treatment also induced quantitative variation for a large number of characters and there is need to practice selection for several generations in order to produce a true breeding mutant line. (auth)

59037 DOES N-ETHYLMALEIMIDE RESTORE MUTATIONAL DAMAGE UNDER AEROBIC RADIATION CONDITIONS? Kesavan, P. C. (Dalhousie Univ., Halifax, Nova Scotia). Indian J. Genet. Plant Breed.; 31: No. 1, 122-5(Mar 1971).

The data presented herein suggest that the γ-radioinduced chlorophyll mutation frequency in barley is reduced (protection or recovery from radiation damage?) by N-ethylmaleimide under aerobic conditions. However, there is no indication of the expected radiosensitization of such mutational damage by NEM under anaerobic conditions of irradiation. The problem caused by the involvement of "oxygen-effect" in comparative studies to assess the influence of NEM under aerobic and anaerobic conditions of irradiation was briefly discussed. (auth)

59038 HAPLOID INDUCTION IN SOLANUM TUBEROSUM L BY IRRADIATION OF THE POLLEN. Pamfil, C.; Marin, E.; Goia, E. Lucr. Stiint., Inst. Agron. Cluj, Ser. Agr.; 26: 311-19 (1970). (In Rumanian).

The paper gives the results obtained in experimental work regarding the effect of haploid induction in Solanum tuberosum applied through a combined method: hybridization between the species and x irradiation of the pollen. The results attest that the practice of hybridization between the species in conjunction with doses of 1500 to 2000 R irradiations of the pollen resulted in more numerous haploid plants than in the case of each method applied separately. The work also gives a description of the morphological characters of the newly obtained haploid forms, pointing to the fact that the decreasing number of seeds and the reduced germinating capacity of the seeds is proportional to the progressive irradiation dose. (Rom. Sci. Abstr.)

59039 MUTATIONS IN SOYBEANS INDUCED BY X RAYS. Seboek, C. Lucr. Stiint., Inst. Agron. Cluj, Ser. Agr.; 26: 341-6(1970). (In Rumanian).

Mutations induced by x irradiations (15 and 20 kR) in dry soybean seeds were studied. The artificial induction of mutants in soybeans is an efficient means by which a breeding material of high genetic variability of qualitative and quantitative value may be obtained. (Rom. Sci. Abstr.)

59040 TWISTED STEM: A USEFUL MUTATION IN JUTE (C. CAPSULARIS L.). Singh, D. P.; Jana, A. K. (Jute Agricultural Research Inst., Barrackpore, India). Curr. Sci. (India); 41: No. 20, 744(20 Oct 1972).

A twisted stem mutant was isolated from a field of jute plants (Corchorus capsularis) exposed to chronic γ irradiation. The mutant was picked up at a dose rate of 3.5 kR/hr. The twisted stem mutant, with the bark arranged on the main stem in a cyclic manner, is beneficial with respect to resistance to lodging and storm damage. Some resistance to stem weevils has been noted also, probably due to the unusual pattern of bark growth. (E.R.B.)

59041 ALTERED PATTERN OF INTERNODE ELONGATION IN AN X-RAY INDUCED DWARF MUTANT OF AN INDICA RICE VARIETY HR 5. Narahari, P. (Bhabha Atomic Research Centre, Trombay, India). Curr. Sci. (India); 41: No. 20, 741-2(20 Oct 1972).

The pattern of internode reduction in the x-radioinduced dwarf mutant of indica rice variety HR 5 is reported. The pattern may be considered to reflect the pleiotropic effects of the mutant gene as the dwarf shows normal heading period. The mutant is of considerable genetic interest. (E.R.B.)

Radiation Effects on Animals (External Source)

Man

Refer also to abstract 59395.

59042 (BARC-519) RADIATION DOSIMETRY OF POPULATION IN MONAZITE BEARING AREAS USING THERMOLUMINESCENT DOSIMETERS. Sunta, C. M.; Nambi, K. S. V.; Kathuria, S. P.; Basu, A. S.; David, M. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 162p. Dep. NTIS (U. S. Sales Only).

Individual thermoluminescent dosimeters were used to measure the radiation exposure dose of a human population residing in the Kerala region of India, a region of high-level natural background radiation, during a 20-month period. Measurements were also made of radioactivity levels in the homes of the people. Results obtained are tabulated for about 10,000 individuals and over 2,700 houses. No attempt is made to analyze the data. (C.H.)

59043 (BNWL-1183-12) MEASUREMENT OF RADIATION EXPOSURE OF ASTRONAUTS BY RADIOCHEMICAL TECHNIQUES. Quarterly Research Report to the NASA Manned Spacecraft Center, April 3-July 2, 1972. Brodzinski, R. L. (Battelle Pacific Northwest Labs., Richland, Wash.). 15 Jul 1972. Contract AT-(45-1)-1830. 22p. Dep. NTIS.

Cosmic radiation doses to the crews of the Apollo 14, 15, and 16 missions of 142 ± 80, 340 ± 80, and 210 ± 130 mR respectively were calculated from the specific activities of ^{22}Na and ^{24}Na in the postflight urine specimens of the astronauts. The specific activity of ^{59}Fe was higher in the urine than in the feces of the Apollo 14 and 15 astronauts, and a possible explanation is given. The concentrations of ^{40}K, ^{42}K, ^{51}Cr, ^{60}Co, and ^{137}Cs in the urine are also reported for these astronauts. The radiation doses received by pilots and navigators flying high altitude missions during the solar flare of March 27 to 30, 1972 were calculated from the specific activity of ^{24}Na in their urine. These values are compared with the expected radiation dose calculated from the known shape and intensity of the proton spectrum and demonstrate the magnitude of atmospheric shielding. The concentrations of Na, K, Rb, Cs, Fe, Co, Ag, Zn, Hg, As, Sb, Se, and Br were measured in the urine specimens from the Apollo 14 and 15 astronauts by neutron activation analysis. The mercury and arsenic levels were much higher than expected. No significant differences were observed between pre- and postflight samples. (auth)

59044 (LA-5041) PHYSICAL AND BIOLOGICAL ASPECTS OF HIGH LET RADIATIONS WITH REFERENCE TO RADIOTHERAPY. Raju, M. R. (Los Alamos Scientific Lab., N. Mex.). Sep 1972. Contract W-7405-eng-36. 20p. Dep. NTIS.

This report is presented for a mixed audience such as physicists, radiation biologists, and radiation therapists interested in the use of high LET radiations in radiation therapy. The particles covered are protons, heavy ions, negative pions, and fast neutrons. The following topics are covered: current progress and limitations of conventional radiations in radiotherapy, the rationale for the use of high LET radiations in therapy, interaction of different types of radiations with matter, physical aspects of high LET particles, biological effects as a function of LET, radiobiology and radiotherapy of high LET radiations, clinical implications of better localization, and comparison of dose and effective dose-distributions for the particles covered. It was concluded that these radiations are complementary and do have potential application in radiotherapy. (auth)

59045 ACTIONS OF RADIATIONS ON HUMAN CHROMOSOMES. Evans, J. H. (Western General Hospital, Edinburgh). Phys. Med. Biol.; 17: No. 1, 1-13(Jan 1972).

Research on the induction of aberrations in human chromosomes by radiation is reviewed. The subject is discussed under the following headings: materials and methods; physical factors influencing aberration yields, especially the relationships between dose and aberration yield; biological factors influencing aberration yields e.g., the effect of age and chromosome constitution; in vivo exposures and biological dosimetry, with especial reference to work on rabbits; and the biological consequences of the presence of aberrations. (UK)

59046 LATE RADIATION INJURIES OF THE SKIN AND THEIR TREATMENT. Vitkin, B. S. (City Hospital No. 26, Leningrad). Vop. Onkol.; 18: No. 4, 81-5(1972). (In Russian).

The author presents an analysis of the results of observation of 32 patients in whom tumors developed after x ray therapy of noncancer lesions of the skin. These were treated successfully by means of 2% colchamine ointment. (auth)

59047 EXPERIMENTAL CLINICAL EVALUATION OF BLOOD FORMATION IN LOCAL IRRADIATION. Jarmonenko, S. P.; Vermel, A. E.; Zubrichina, G. N.; (and others) (Inst. of Experimental and Chemical Oncology, Moscow). Radiobiol.-Radiother.; 13: No. 4, 499-509(1972). (In German).

A clinical experimental analysis of the condition of blood-formation in local irradiation is given. One hundred and sixty-seven patients with malignant tumors of different localization were observed. The conditions of irradiation differed according to the volume of the directly irradiated bone-marrow. In patients with esophageal cancer—4 to 8%, in those with lymphogranulomatosis up to 25% of active bone-marrow fell into the radiation zone. In patients with local irradiation, leukopenia is mainly based on the decrease of the lymphocyte count less than that of neutrophils. Lymphopenia mainly is a consequence of the direct destruction of lymphocytes in their passage through the radiation zone. That is confirmed by the examinations with the local irradiation of the tail of experimental animals. The morphological and cytogenetic examination of the blood-forming elements show the absence of visible damages of the cells in the screened parts of the bone marrow. The decrease of the number of neutrophils and the reduced flooding-out of the granulocytes in man as a response to the injection of pyrogenal does not correlate with the low amount of the irradiated bone-marrow. In the irradiation of the tail of experimental animals a decrease of neutrophils was also observed although active bone-marrow was not irradiated. All the results represented speak for the nature of distance of neutropenia that is observed with the local irradiation of the organism. Amongst others it cannot be excluded that this phenomenon is of a toxemic nature. (auth)

59048 DENTAL RADIOLOGY: A PERSPECTIVE ON PRIORITIES. Barr, John H. (Tufts Univ., Boston). Oral Surg., Oral Med., Oral Pathol.; 34: No. 4, 672-9(Oct 1972).

The clear definition of basic technical objectives in dental radiology has escaped any substantial attention up to this point in time. Through recent years, specific opportunities for well-supported action in the interests of patients has also escaped attention. To these apparent shortcomings in the assignment of priorities for their efforts, there may well be need to add some new but related problems, stemming from certain trends currently developing within the dental profession and its specialities. (auth)

59049 WORKING CONDITIONS AND STATE OF HEALTH OF RADIOGRAPHERS. Gorbarenko, N. I.; Sokolina, L. L.; Musina, N. P.; (and others) (Inst. of Hygiene and Occupational Disease, Moscow). Gig. Sanit.; No. 6, 32-4(Jun 1972). (In Russian).

The paper deals with working conditions, dosimetric and periodic medical examination of 270 industrial radiographers. The finding is that irradiation doses of workers do not exceed the maximal permissible levels. Certain shifts were noted in the peripheral blood: a low number of leukocytes and thrombocytes was found in $^1/_5$ of the examined persons. (auth)

59050 CONSIDERATION OF FRACTIONATION SCHEDULES FOR RADIATION DOSE. Suit, Herman D. (Univ. of Texas, Houston). Radiology; 105: No. 1, 151-6(Oct 1972).

Three physical parameters may be manipulated in fractionation: the number of fractions, the interval between fractions, and the dose rate. The four biological processes that determine the response of the tissue to irradiation are repair, redistribution, repopulation, and reoxygenation. In fractionated irradiation, the TCP (tumor control probability) and NP (normal tissue necrosis probability) are determined by the kinetics of these processes. For any one dose fractionation schedule, there is a corresponding TCP—NP relationship. One or more of these processes might be expected to alter this relationship as the fractionation schedule is changed. (auth)

59051 NOMOGRAPHIC TECHNIQUE FOR THE ISOCENTRIC COMPUTATION OF ^{60}Co CENTRAL RAY DEPTH DOSE. Randall, Gerald J.; Henning, Donald; Holt, J. Garrett (Memorial Hospital, New York). Radiology; 105: No. 1, 177-80(Oct 1972).

A nomographic technique for computation of depth dose of ^{60}Co at areas along the central axis is presented. A calculator composed of two sets of graphs and two pointers connected by an elastic cursor is used to obtain the depth dose rather than working inverse square law calculations and using TAR and TMR tables as has been previously required for isocentric teletherapy computations. The feasibility of extending this calculator design to other high energy teletherapy machines is discussed. (auth)

59052 X-RAY EXPOSURE REDUCTION USING RARE-EARTH OXYSULFIDE INTENSIFYING SCREENS. Buchanan, Robert A.; Finkelstein, Solon I.; Wickersheim, Kenneth A. (Lockheed Palo Alto Research Lab., Calif.). Radiology; 105: No. 1, 185-90(Oct 1972).

The characteristics of terbium-activated gadolinium oxysulfide and lanthanum oxysulfide are compared with those of calcium tungstate. The new rare-earth phosphors have higher x-ray absorption in the 38 to 70 keV region relative to calcium tungstate. They also exhibit a larger x-ray-to-visible light energy conversion efficiency. Rare-earth phosphors, however, emit primarily in the green spectral region and thus poorly match the spectral response of blue-sensitive x-ray film. Despite this disadvantage, gadolinium oxysulfide screens allow a significant x-ray exposure reduction relative to calcium tungstate screens providing equivalent resolution. An additional exposure reduction is anticipated when faster green-sensitive x-ray film becomes available. (auth)

59053 EFFECTS OF RADIATION THERAPY ON BONE LESIONS AS MEASURED BY ^{47}Ca AND ^{85}Sr LOCAL KINETICS. Greenberg, E. J.; Chu, F. C. H.; Dwyer, A. J.; (and others) (Sloan-Kettering Inst. for Cancer Research, New York). Contract AT(30-1)-910. J. Nucl. Med.; 13: No. 10, 747-51(Oct 1972).

A study was carried out to investigate the sequential changes of uptake and retention of ^{47}Ca and ^{85}Sr after radiation therapy of malignant bone lesions and to correlate these changes with clinical symptoms and roentgenographic findings. Eight patients with bone metastases from breast carcinoma and one patient with primary reticulum cell sarcoma of the bone were studied. Calcium-47 given prior to radiotherapy and at intervals of 1 to 4 months afterward served to measure the changes in uptake of mineral by bone over a 1-yr period. A single dose of ^{85}Sr given prior to therapy as a labeling dose to the skeleton was measured at similar intervals as an index of the rate of loss of mineral bone. The majority of patients exhibited a rise in ^{47}Ca uptake by tumor-involved bone 1 to 2 months after radiation therapy, followed by a gradual fall. A relative increase of ^{85}Sr retention in the irradiated bone was observed and these two processes of increased uptake and higher retention of minerals lead to a recalcification of previously destructive lesions. Practically all the patients experienced a relief of pain and showed radiographic evidence of recalcification. (auth)

59054 POSTIRRADIATION RESTORATION OF HEMOPOIESIS THROUGH TRANSPLANTATION OF AUTOLOGOUS BONE MARROW. **Strelin, G. S.; Shmidt, N. K.; Rudakov, I. A.** (Central Scientific Research Inst. of Roentgenology and Radiology, Moscow). Usp. Sovrem. Biol.; 72: No. 3, 375-90(1971). (In Russian).

Literature on experimental methods of treating radiation sickness by transplanting compatible bone marrow tissue is reviewed, with 146 references cited. Emphasis is placed on two methods: removing and preserving a certain quantity of the bone marrow to irradiation and reimplanting it into the donor after irradiation; and utilizing bone marrow from areas which were protected during exposure to radiation and infusing them into the patient's circulation to speed up the natural process of dissemination of healthy bone marrow cells. The role of the various bone marrow cells, especially the stem cells, in the development of and recovery from radiation sickness is discussed. (JPRS)

59055 TREATMENT OF RADIATION-INDUCED COLITIS WITH SALICYLAZOSULPHAPYRIDINE (AZULFIDINE). **Rauch, K.; Weiland, H.** (Krankenhauses Nordwest, Frankfurt am Main). Strahlentherapie; 143: No. 6, 660-3(Jun 1972). (In German).

The treatment of 50 female patients with uterine carcinoma, suffering from irradiation-induced colitis, with salicylazosulphapyridine (Azulfidine®) is reported. As a rule, a dose of 5 times 2 dragées (= 5.0 g) and 3 times 1 suppository (= 1.5 g) a day will be sufficient to stop the severe diarrhea within a few days. Under this medication, exposure pauses are in most of the cases not necessary anymore. The application of corticosteroids, especially unfavorable in cancer patients, can be avoided. The treatment of irradiation-induced colitis with Azulfidine® is superior to other therapeutic trials; at present it is considered to be the treatment of choice. It has not yet been confirmed that radiation-induced late injuries on the rectum and sigmoid can be even more diminished owing to the good therapeutic response of the acute irradiation-colitis. A great number of observations of the course would be necessary for this proof, including irrigoscopic and rectoscopic control examinations. (auth)

59056 INFLUENCE OF VARIOUS IRRADIATION RHYTHMS ON TUMOUROUS AND NORMAL TISSUE IN VIVO. **Eichhorn, H.-J.; Lessel, A.; Rotte, K.-H.** (Robert-Roessle-Klinik, Berlin). Strahlentherapie; 143: No. 6, 614-29(Jun 1972). (In German).

Two human tumors (bronchial and esophageal carcinoma) and two normal tissues (from the lung and the spinal marrow) were used to investigate in vivo for the influence of fractionation rhythm on the x radiation effect. Under the condition of equal total doses, different irradiation modes were compared as follows: daily•low single doses (250 R TD), high single doses (600 R TD) applied every 5th day, one (600 R TD) and three (1000, 800, 800 R TD) high initial doses, followed by daily low single doses and split-series with daily low single doses, after an interval of 5 up to 10 days. To test the radiation effect, an accurate histological examination of the autopsy preparation (no serial sections) was carried out, with the criterion of complete destruction of the tumor, the x-ray demonstration of radiation fibrosis, or the appearance of a transverse lesion. The homogeneity of the compared series (tumor size, total dose and total duration of exposure, histological type of tumors, equal mortality rate due to the basic disease) was analyzed statistically and proved to be comparable. The bronchial carcinoma only, most exactly investigated, showed a better effect if a high initial dose was given, followed by daily low single doses, in contrast to the effect attained by high single doses given every 5th day. None of the other fractionation rhythms tested showed any statistically significant difference in action. This result does not correspond with the experimental radiobiological investigations nor with the hypothesis of the newer literature. It confirms, however, former results obtained by the authors' own investigations on three series of operable bronchial carcinomas. In these examinations, too, high single doses showed the lowest tumor-destructive effect. The bronchial carcinoma therefore seems to behave like moulting tissue: low daily single doses prove to be more effective than high single doses applied every 5th day. We presume that, in case of daily irradiation, a maximal amount of tumor cells absorbs the maximal total dose during the most radiosensitive phase of division. (auth)

59057 VISUAL PERCEPTION OF ACCELERATED NITROGEN NUCLEI INTERACTING WITH THE HUMAN RETINA. **Budinger, T. F.; Lyman, J. T.; Tobias, C. A.** (Univ. of California, Berkeley). Nature (London); 239: No. 5369, 209-11(22 Sep 1972).

It is stated that visual phenomena have been observed with high energy N beams produced at the Berkeley Bevatron. The experimental procedure, made with three scientifically trained subjects, is described; the observations confirmed earlier arguments for electronic excitation in or near the outer segments of the retina as the important mechanism. When the beam was passed through the vitreous body or optic nerve no streaks or flashes were seen, but on passage through the posterior globe discrete bright flashes, sometimes in clusters or interspersed with streaks, were seen. The colorless streaks were usually horizontal, and most were observed in the upper visual field. Some of the flashes may have been due to various heavy fragments, He-ions and protons. The visual effects were seen only when the beam was positioned in the posterior portion of the eye. Comparisons are made with effects reported by astronauts during space flights. The phenomena appeared to be dependent on dark adaption. (UK)

59058 MORTALITY EXPERIENCE OF URANIUM AND NONURANIUM WORKERS. **Scott, L. M.; Bahler, K. W.; De La Garza, A.; Lincoln, T. A.** (Union Carbide Corp., Oak Ridge, Tenn.). Health Phys.; 23: No. 4, 555-7(Oct 1972).

A study was made of mortality rates of uranium and nonuranium workers in two facilities, (Oak Ridge Gaseous Diffusion and Y-12 plants), processing massive quantities of uranium. The uranium worker group consisted of over 4500 employees with a total of about 14,000 man-yr of association with uranium processing. It was concluded that the mortality experience was more favorable for the uranium workers than for the nonuranium workers in the same plants during the same period. (auth)

59059 GENETIC EFFECTS OF LOW AND HIGH-ENERGY RADIATION. **Pasinetti, Antonio** (Univ., Milan). Ind. At. Spatiales; 16: No. 2, 35-45(Mar 1972). (In English and French).

A certain percentage of spontaneous mutations may be attributed to natural radioactivity in the terrestrial environment. It is necessary to determine the rate of occurrence of spontaneous mutations corresponding to a given characteristic, before attempting to assess the genetic mutations induced by artificial mutagenic agents, and to evaluate the risk and possible damage to future generations derived from a population exposed to radiation. Studies of the ionization produced along the trajectory of a particle carried out by biophysicists have enabled the physical interactions responsible for the genetic mutation to be determined. The determination of the ratio between the absorbed dose and the frequency of mutation has led to the establishment of international norms for radioprotection. (France)

59060 RADIOBIOLOGICAL ASPECTS OF FAST NEUTRON THERAPY. **Field, S. B.** (Hammersmith Hospital, London). Proc. Roy. Soc. Med.; 65: No. 10, 835-9(Oct 1972).

A brief account of a 1 day meeting is given. The relationship between RBE and dose was discussed in relationship to an analysis of tissues irradiated with fast neutrons (mean energy 7.5 MeV) from the cyclotron at Hammersmith Hospital. Tissues considered are skin, hemopoietic tissues, intestine, and cartilage. The oxygen effect was also discussed. A brief outline review of clinical trials is made, with particular reference to dose fractionation and to tumors of the head and neck, stomach carcinoma, adenocarcinoma of the large intestine, pancreas and breast tumors, and soft tissue sarcoma. Other problems in relation to the use of high LET radiation in radiotherapy are briefly mentioned, such as physical problems, distribution of the radiation, clinical trials, and statistical problems. (UK)

59061 IONIZING RADIATION AS A FACTOR OF LABOUR ENVIRONMENT IN THE REPAIR LABORATORIES OF THE CIVIL AIR TRANSPORT (SECOND COMMUNICATION). **Vasilev, G.; Filev, G.; Dermendziev, Hr.; Vitev, V.; Karadzov, At.** Trans.-Med. Vesti; 16: No. 2, 32-6(1971). (In Russian).

The characteristics of radiation fields in the laboratories for equipment repair and for trial and repair of board locators were studied by measuring beta- and gamma-radiation, intensities of super-frequency (SF) electromagnetic field, soft roentgen radiation, and radioactive pollution of hands, clothes, and work surfaces. The following results were obtained: 1) External irradiation of the staff during repair and maintenance of aircraft supplied with board dials painted with radioactive light emitting dyes or control devices using radioactive isotopes is far below the maximal admissible dose for occupational irradiation. 2)

The levels of radioactive contamination of the working tables and hands of workers employed with the repair of devices painted with light-emitting radioactive dye vary within broad limits and exceed many times the maximal admissible doses. 3) Workers employed with repair and tuning of radiolocators are in a SF electromagnetic field where the stream power is quite high and may reach dangerous levels. 4) Soft x-ray treatment generated from modulator lamps and spreading with the equipment case removed has an average energy of 25 keV. The power of exposure doses which varies in changing the distance from the source is not great. Measures are suggested guaranteeing radiation security. (Abstr. Bulg. Med. Lit.)

59062 X RAY DERMATITIS. Kishi, Masahiro (Kurume Univ., Fukuoka). Nishi Nippon Hifuka; 32: No. 5, 409-14(Oct 1970). (In Japanese).

Two cases of skin injury after long-term exposure to x radiation are reported. A 56-year-old male received weekly irradiation for the treatment of marginal eczema on the inner side of the femoral region. Single dose was 100 R and irradiation was continued for 3 years, presumably making the total dose 10,000 R. Skin eruption spread gradually, showing erythema, pigmentation, depigmentation, and peripheral dilatation, the symptoms of x-ray-induced dermatitis. A 55-year-old female received x irradiation once a week for 3 years for the treatment of contact dermatitis on the upper surface of fingers on both hands produced by the use of rubber gloves. Total dose in this case was assumed to be around 1000 R. Pigmentation with indistinct margin, depigmentation, skin atrophy, and cuticular proliferation were present, with irregularly shaped erosion or ulcer of various sizes. Biopsied specimen from the left hand showed the presence of thickened squamous cell layer and formation of ulcer. The skin symptoms in the male patient were cured by surgery and that of the latter female patient by intravenous injection of bleomycin for about 3 months. (Japan)

Vertebrates

Refer also to abstract 58992.

59063 (AECL-4272, pp 25-31) POPULATION RESEARCH. Newcombe, Howard B. Sep 1972.

Research on hereditary changes in vertebrates included studies on low-dose effects in fish embryos from irradiated sperm and chromosome cytology of irradiated fish. Methods for deriving human data on diseases likely to be increased by irradiation were studied with regard to organization of birth and marriage records and ascertainment of congenital malformations through hospital records. A proposal for studies on cancer incidence following multiple fluoroscopic radiography of human populations is described. (H.L.W.)

59064 ACTIVITY OF SOME HYDROLYTIC ENZYMES IN THE SMALL INTESTINE OF RATS IRRADIATED DURING PRENATAL DEVELOPMENT. Trojczuk, Dina; Owdiejczuk, Regina. Acta Physiol. Pol.; 23: No. 4, 647-54(1972). (In Polish).

X irradiation of rat embryos during functional differentiation of the small intestine caused significant increase of intestinal β-galactosidase, β-fructofuranosidase, and glycyl-leucine dipeptidase activities, during the early period of postnatal life. The changes were transient and the activities of the enzymes returned gradually to normal levels in parallel with the functional maturation of neurohormonal regulation centers. (auth)

59065 EFFECT OF X-RAY IRRADIATION OF ANIMALS ON THE ACTION INTENSITY AND PHARMACOKINETICS OF MORPHINE. Szczawinski, Rajmund; Chodera, Alfons; Kozaryn, Irena; Wojciakowa, Zofia. Acta Physiol. Pol.; 23: No. 4, 655-62 (1972). (In Polish).

The action dynamics of morphine and its pharmacokinetics (resorption, distribution, biotransformation, and excretion) in rats irradiated with 300 R, 600 R, and in control animals were compared. (auth)

59066 EFFECT OF INSULIN ON THE RADIOPROTECTIVE ACTION OF DIANABOL. Kiluk, Stanislaw; Danysz, Andrzej; Killar, Marian; Wisniewski, Konstanty. Acta Physiol. Pol.; 23: No. 4, 663-71(1972). (In Polish).

The effect of insulin on the radioprotective action of dianabol was studied. It was found that the administration of both dianabol and insulin caused a decrease in mortality in mice, a diminution of the decrease in body weight, a complete normalization of the o-quinones level in the irradiated liver tissue and intestine, and a decrease in the catheptic activity in both tissues investigated. The radioprotective effects in the evaluation of the survival rate and the changes in body weight were greater in the group of animals administered dianabol and insulin jointly. (auth)

59067 ANALGESIC EFFECTIVENESS OF MORPHINE IN IRRADIATED MICE. Kocmierska-Grodzka, Danuta; Kozlowska, Maria. Acta Physiol. Pol.; 23: No. 1, 149-57(1972). (In Polish).

The reactivity of adult mice to the analgesic action of morphine in the course of postirradiation syndrome was investigated. The periodic changes in the analgesic activity of morphine in animals irradiated with doses of 200 and 400 R of x rays were stated. During the first three days after irradiation, a tendency to decrease the analgesic activity of morphine was observed—while in the subsequent period the analgesic activity of the drug was increased. The peak of the analgesic effectiveness of morphine was observed on the 8th day after irradiation. (auth)

59068 REACTION OF THE SMALL INTESTINE OF GUINEA PIGS TO BARIUM CHLORIDE IN IRRADIATION SICKNESS. Wisniewski, Konstanty; Piekarska, Teresa; Danysz, Andrzej. Acta Physiol. Pol.; 23: No. 1, 159-66(1972). (In Polish).

Investigations were carried out on the reaction of the guinea pig small intestine to $BaCl_2$ in irradiation sickness. It was found that irradiation induced a considerable reduction (1000 X after irradiation with a dose of 450 R) of the reaction to $BaCl_2$ of the periduodenal part and—to a somewhat lesser extent—of the median part of the small intestine, in particular on the 6th day after irradiation. No differences were, however, found in the reaction of the ileum to $BaCl_2$. It was also shown that the above changes were accompanied by a slight increase in the level of ACH and a drop in the activity of ACHE. The greatest effects after irradiation were found in the periduodenal part of the small intestine. A simple relationship was shown to exist between the amount of decrease in the reaction of the isolated small intestine to $BaCl_2$ and the dose of irradiation. The results obtained point out that the changes in reaction of the small intestine to $BaCl_2$ may be used as a comparatively sensitive test for assessing the degree of irradiation injuries and of the intensity of action of substances protecting against radiation effects. (auth)

59069 INCREASED RADIORESISTANCE OF MICE AFTER INTRACEREBRAL INJECTION OF 5-HYDROXYTRYPTAMINE. Streffer, C.; Fluegel, M. (Univ., Freiburg i. B.). Biophysik; 8: No. 4, 342-51(1972). (In German).

The survival rate of mice was studied after whole-body x irradiation and intracerebral injection of 5-hydroxytryptamine. An increase of the survival rate was observed when the intracerebral injection was performed before irradiation. The dependence of the protective effect on the period between injection and irradiation as well as the dose reduction factor of the $DL_{50/30}$ are identical with observations made after the intraperitoneal administration of 5-hydroxytryptamine. The intracerebrally injected amine is rapidly metabolized in the brain and the metabolites leave the CNS. In the peripheral organs, only metabolites of 5-hydroxytryptamine were observed. From these investigations and histo-autoradiographic results, it is assumed that the radioprotective effect of the amine is induced in the CNS, possibly in hypothalamic regions. Centranervous regulatory processes bring about changes in the peripheral organs that lead to the increased radioresistance of the organism. The characteristics of these changes are unknown. Hypothermia induced by 5-hydroxytryptamine can be ruled out in this connection. The participation of hypoxic effects cannot completely be excluded. (auth)

59070 EFFECT OF ANTI-INFLAMMATORY COMPOUNDS ON β-IRRADIATION INDUCED RADIODERMATITIS. Chung, J.; Song, C. W.; Yamaguchi, T.; Tabachnick, J. (Albert Einstein Medical Center, Philadelphia). Dermatologica; 144: 97-107(1972).

The effect of several anti-inflammatory agents given per os, intraperitoneally, or topically to alleviate acute radiodermatitis in guinea pig skin following 3,000 to 4,000 rep β irradiation was studied. Up to the 21st day postirradiation, there was pronounced suppression of the acute inflammatory response observed with chloroquine diphosphate, or meclofenamic acid (Cl-583). Chloroquine diphosphate given systemically was most potent among the single drugs tested. Qualitatively, combinations of the drugs given per os were somewhat more effective in suppression of the second erythema and late skin reactions. Topical application of 50% DMSO or of anti-inflammatory drugs dissolved in this solvent resulted in increased inflammatory reactions. Triamcinolone acetonide appeared to be the only active compound when applied topically. The effective anti-inflammatory agents decreased the frequency but did not prevent the onsets of ulcers. Ulceration was delayed by about 10 days in the drug-treated animals (as compared with its appearance by the 20th day in controls) and the ulcerated area was smaller and healed more rapidly. (auth)

59071 RADIOSENSITISERS. Lancet; 2: No. 7778, 638-40(23 Sep 1972).

Editorial comment is made and a brief outline review presented of progress in radiosensitizing techniques. Brief mention is made of methods of overcoming the O_2 effect, (hyperbaric O_2, neutrons etc.). Animal experiments with paranitroacetophenone (NDPP) are mentioned, together with tretamine, fluorouracils, actinomycin, methotrexate. It is pointed out that synkavit is the only true sensitizer, because it alone improves the therapeutic ratio. (UK)

59072 HUMAN TUMOURS GROWN IN MICE. Castro, J. E. (Medical Research Council, London). Nature (London) New Biol.; 239: No. 90, 83-4(20 Sep 1972).

Experiments were made to maintain various human tumor tissues in previously irradiated mice. The mice were thymectomized at the age of 4 weeks, 2 weeks later given 900 rad whole body irradiation, and within 24 hr, 5×10^6 syngeneic bone marrow cells were injected intravenously. Then 3 weeks to 3 months later, they received, beneath the kidney capsule, grafts of various human malignant tumor tissues. Mice were killed 2, 4, 8 and 12 weeks after tumor implantation. Eight tumor types from 23 patients were implanted, and 2 weeks later, 15 were considered viable. (UK)

59073 STUDIES ON KININ-FORMING ACTIVITY IN POST-RADIATION SICKNESS. PART I. BLOOD AND TISSUES ENZYMATIC ACTIVITY. **Kocmierska-Grodzka, D.** (Medical Academy, Bialystok, Poland). Radiobiol.-Radiother.; 13: No. 4, 443-52(1972).

The activity of blood and tissues kinin-forming activity in rats irradiated with the lethal dose of x rays was investigated. There was found an increased level of kinin-like substances in the blood despite a decrease in kinin-forming activity as well as a decrease in fibrinolytic system activity in irradiated rats. Parallel to the enhanced activity of tissue kallikreins and cathepsin B were found. The participation of tissue enzymes (kallikreins and cathepsin) in post-radiation kinin-forming activity in the early period of illness is suggested. (auth)

59074 STUDIES ON KININ-FORMING ACTIVITY IN POST-RADIATION SICKNESS. PART II. INVESTIGATIONS INTO BIOLOGICAL ACTIVITY OF LYSOSOMAL ENZYMES PREPARATE. **Kocmierska-Grodzka, D.** (Medical Academy, Bialystok, Poland). Radiobiol.-Radiother.; 13: No. 4, 453-8(1972).

In view of the possible participation of lysosomal enzymes in post-radiation kinin-forming activity in rats the biological properties of lysosomal preparate was investigated. It was stated that lysosomal enzyme preparate evokes: writhing syndrome, fall in the blood pressure, contractile effect against rat intestine, and enhanced vascular permeability. Most of these effects are similar to those caused by bradykinin or kinin-forming enzymes. The possible role of lysosomal enzymes involved through creation of kinin-like-effects in arising of the characteristic symptoms of postirradiation syndrome is discussed. (auth)

59075 PECULIARITIES OF ERYTHROPOIESIS OF ANIMALS AFTER AN ACUTE RADIATION SICKNESS. **Smeleva, N. J.** Radiobiol.-Radiother.; 13: No. 4, 479-89(1972). (In German).

In a later period after a single total irradiation of rats with a dose of 500 rads (after 9 to 12 months) an intensification of the erythropoietic activity of the bone-marrow with simultaneous accelerated aging and destruction of the erythrocytes in the irradiated organism was shown. The results allow the assumption that in later periods after irradiation the life of erythrocytes is shortened. (auth)

59076 COMPARATIVE EXAMINATIONS OF THE DAMAGING EFFECT OF A WHOLE-BODY X-IRRADIATION OF 17 kV, 50 kV, AND 180 kV. **Avetisov, G. M.; Budylin, V. N.; Gorlov, V. S.; Grammatikati, V. S.** Radiobiol.-Radiother.; 13: No. 4, 491-8 (1972). (In German).

In an examination of 354 non-bred rats, a comparative study of the damaging effect of whole-body x irradiation with 17, 50, and 180 kV was made. Data of dose dependence for lethality, clinic of the disease, time of death of the animals, dynamics of body weight, changes of values of the peripheral blood, and the condition of bone-marrow blood formation are represented. Possible mechanisms of pathogenesis and thanatogenesis are discussed. (auth)

59077 NATURE AND PROGNOSTICAL IMPORTANCE OF LEUKOPENIA IN LARGE-FIELD IRRADIATION OF MICE. **Revelskaja, T. A.; Redkina, E. K.; Jarmonenko, S. P.** Radiobiol.-Radiother.; 13: No. 4, 511-20(1972). (In German).

An experimental analysis of the peculiarities of radiation injury in the irradiation of large segments of the body of mice is represented. The experiments were made with 1108 mature hybrid mice (CBA × C_{57}BI) F_1 being exposed to a large-field external effect of gamma radiation of ^{137}Cs. 31, 54, and 85% of the blood-forming tissue fell to the zone of radiation effect. Leukopenia, which develops with all types of large-field irradiation, depends up to about 1000 R on the radiation dose and on the volume of the irradiated hematopoietic tissue. Equilethal doses of total irradiation and of large-area irradiation differ considerably in the degree of leukopenia and reverse; with the same decrease of the elucocyte count in the blood different lethal effects of whole-body irradiation and segment irradiation are observed. It is imaginable that with the irradiation of large segments of the body a peculiar toxemic syndrome develops and the death of the animals under the given conditions is not of a hematological type. The correlation between the extent of the decrease in the leucocyte count and lethality for all variants of irradiation including the total one is especially low in that dose range causing the death of the animals in 30 to 70%. This shows the small prognostical value of leukopenia as an index of the final picture of radiation injuries. (auth)

59078 EXPERIMENTAL EXAMINATIONS ON THE OPTIMUM CONDITIONS OF USING HETEROLOGOUS DNA FOR THE TREATMENT OF ACUTE RADIATION SICKNESS OF RATS. **Evseeva, N. K.; Uspenskaja, M. S.; Mazurik, V. K.** Radiobiol.-Radiother.; 13: No. 4, 471-8(1972). (In German).

Heterologous DNA shows a therapeutic effect on radiation sickness of rats after ^{60}Co gamma ray whole-body irradiation in not absolutely lethal doses with a dose rate of 438 to 649 R/min. DNA preparations cause nearly the same survival rate (40.1 to 43.2% compared with 21 to 22% of the control) injected 1 h as well as 24 h after the irradiation of the animals. DNA doses of 1 to 4 mg per animal practically showed the same therapeutical effectiveness if they are injected 24 h after irradiation. A repeated injection of DNA did not increase the survival rate. For the rats treated with DNA preparations who were irradiated with 700 R of ^{60}Co gamma radiation, nearly the same effect was found for a lower (17 R/min) as well as for a higher (438 to 649 R/min) dose rate. (auth)

59079 DYNAMICS OF HEMATOPOIETIC REACTIONS UNDER CONCURRENT CONDITIONS OF ISCHEMIA AND IRRADIATION. **Gloskowska-Moraczewska, Zofia; Grabarczyk-Malinowska, Maria** (Inst. of Hematology, Warsaw). Acta Physiol. Pol.; 22· No. 6, 858-69(1971). (In Polish).

Experiments were carried out on male white rats to examine hematopoietic reactions induced by post-bleeding anemia, using the dynamics of reticulocyte formation in animals exposed to high doses of ionizing radiation. It was found that bleeding without irradiation induced hematopoiesis but resulted in a decrease in the number of reticulocytes in the peripheral blood. Bleeding 24 hours after irradiation shortened the lifespan of the animals and accelerated the irradiation-induced depression of the hemapoietic process, leading to the extinction of reticulocytes in the peripheral blood. On the other hand, bleeding three hours before irradiation exerted a protective effect, increasing the survival rate of the animals, and induced regenerative reactions in the erythrocytes. These correlations were confirmed by observations of the post-bleeding changes in the erythrocytes, such as oxygen deficiency and reticulocyte number. (TTT)

59080 EFFECT OF X RAYS AND VARIOUS COMBINATIONS OF CYTOTOXIC SUBSTANCES ON TISSUE INCOMPATIBILITY IN RATS. **Ter-Avetisyan, A. T.** Biol. Zh. Arm.; 24: No. 12, 68-72(Dec 1971). (In Russian).

Groups of white rats were given a dose of 300 R of x rays, and then received the following immunodepressant substances, either singly or in combination: antilymphocytic serum, trimitan, and thiophosphamide. On the 10th day following irradiation, skin grafts were performed. Both donor and recipient received the same drugs. The results indicated that the use of various combinations of immunodepressants lowered to a significant degree the possibility of immune reactions in both recipient and the donor. (tr-auth)

59081 POSSIBLE ROLE OF ANTITISSUE AUTOANTIBODIES IN THE MECHANISM OF THE PROTECTIVE EFFECT OF PARTIAL-BODY SHIELDING DURING TOTAL-BODY IRRADIATION. **Klemparskaya, N. N.; Kashirin, V. S.** Kosm. Biol. Med.; 6: No. 5, 38-44(1972). (In Russian).

The experiments on 115 white rats have indicated that shielding of one hind-limb increases significantly the amount of antibodies eluted from the muscular tissue as measured during the first 15 min after irradiation. The shielding of the upper abdominal portion, the most effective method of partial-body protection, also induces a significant increase of the autoantibody content in the blood, spleen, and muscular tissue and an elevation of the number of autoantibody forming cells in the blood and liver. An increase of the content of normal autoantibodies at early post-irradiation stages exerts a protective effect since they have the capacity of binding and rendering harmless products of tissue decomposition that emerge under the influence of ionizing radiation. (auth)

59082 LUMINESCENT-CYTOCHEMICAL ANALYSIS OF EARLY RADIATION CHANGES IN DNA AND DNP (DEOXYRIBONUCLEOPROTAMINE) OF THE PITUITARY GLAND. Khamidov, D. Kh.; Khakimov, P. A.; Kolesnikova, S. S. (Inst. of Biochemistry, Tashkent). Uzb. Biol. Zh.; No. 2, 10-13(1972). (In Russian).

White rats were irradiated with ^{60}Co gamma and subsequently decapitated with a minimum of stress factors. The pituitary glands were fixed in alcohol-acetic acid. The intensity of the secondary luminescence of cell nuclei was measured; from this the DNA and DNP contents were estimated. At small doses of radiation the DNA content of the cell nuclei increased, and with large doses a very slight decrease was noted. (K.S.W.)

59083 BEHAVIOURAL MUTAGENESIS IN THE CONVICT CICHLID FISH, CICHLASOMA NIGROFASCIATUM GUENTHER. I. THE REDUCTION OF MALE AGGRESSIVENESS IN THE FIRST POST-IRRADIATION GENERATION. Holzberg, Sebastian; Schroeder, Johannes Horst (Gesellschaft fuer Strahlen- und Umweltforschung, Neuherberg, Ger.). Mutat. Res.; 16: No. 3, 289-96 (Nov 1972).

A comparison was made between the aggressive behavior of groups of 10 convict cichlid males (Cichlasoma nigrofasciatum) derived either from irradiated (500 + 500 R of x rays, 24 hr apart, both to oogonia and spermatogonia) or from sham-treated parents. The male level of aggression was measured as bites delivered to subadult conspecifics per 15 min observation time. For the same individual males the activity was determined by counting the number of 90° turns within 15 min. The aggression was also examined during the first 9 days of the breeding cycle from the day of spawning. A total of almost 10,000 data was computed for the present study. The aggressiveness of the nonmated control F$_1$ males was 3.5 times as high as that of the nonmated males of the irradiated series, and 2.1 times as high for the mated control F$_1$ males as that of the males of the irradiated series. Since the number of 90° turns of completely isolated males did not differ in any way for the two series, the reduction of male aggressiveness of the first postirradiation generation does not seem to be associated with a general lowering of activity. The evolutionary significance of the present findings is discussed in terms of some views on behavioral genetics. (auth)

59084 EFFECT OF POSTIRRADIATION BLEEDING OR ENDOTOXIN ON PROLIFERATION AND DIFFERENTIATION OF HEMATOPOIETIC STEM CELLS. Boggs, Sallie S.; Chervenick, Paul A.; Boggs, Dane R. (Univ. of Pittsburgh). Blood; 40: No. 3, 375-89(Sep 1972).

Bleeding after irradiation failed to affect the time of onset or rate of regeneration of the hematopoietic stem cell compartment as measured by a split-dose irradiation method. Bleeding after a single 600 rad exposure hastened the time of onset of erythropoiesis as measured by spleen colonies and ^{59}Fe uptake, but the early rise was abortive and the second increase began at the same time as the first increase seen in irradiated controls. The largest abortive increase was seen when bleeding occurred within 4 h of irradiation. Lesser effects were seen when bleeding occurred 12 or 24 h after and no effect 48 h after irradiation. A generation time of 6.4 h for a colony-forming cell that forms a colony in 4 days was calculated from the estimated number of cells in one such colony. Injection of cytosine arabinoside at the time of bleeding reduced colony numbers and ^{59}Fe uptake equally in bled and control mice. Injection of 25 μg Salmonella typhosa endotoxin just after irradiation produced a similar early abortive rise in microscopic granulocytic colonies. These results are compatible with a model for pluripotential stem cell compartment in which: differentiation and self-replication occur concomitantly unless the compartment is reduced below approximately 10% of normal size; then self-replication occurs without appreciable differentiation; for a short time (~24 h) after depletion below the threshold, differentiation can occur in response to strong stimuli. (auth)

59085 REACTIONS IN NERVE STRUCTURES OF STELLATE GANGLION CAUSED BY WHOLE-BODY X IRRADIATION. Demidova, G. G. (Inst. of Microbiology and Virology, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR; 18: No. 3, 412-14(1972). (In Ukrainian).

Reactive and dystrophic changes of nerve structures in the stellar ganglion of animals appeared as a result of whole-body radiation at doses of 300 R. Electron microscopic studies were used in the detection of such radiation-induced changes. Relative normalization of a portion of the nerve elements was observed at the end of a month, apparently in response to compensating restorative processes in the nerve system. (tr-auth)

59086 ATTEMPT TO TRANSFER DELAYED ALLERGIC CONTACT SENSITIVITY TO DNCB [1-CHLORO-2,4-DINITROBENZENE] WITH PLASMA. Indgin, S. N.; Inderbitzin, Th. M. (Univ. of Miami, Fla.). Int. Arch. Allergy Appl. Immunol.; 41: No. 6, 868-72(1971).

Lethal total body x-irradiation of DNCB-sensitive guinea pigs failed to release into the plasma a factor capable of transmitting delayed type allergic DNCB contact reactivity to normal guinea pigs. RNA, another factor involved in the transmittance of immunologic reactivity, was not demonstrated in the plasma of these animals. (auth)

59087 SPLIT-DOSE RECOVERY IN EUOXIC AND HYPOXIC NORMAL AND TUMOR CELLS. Phillips, Theodore L. (Univ. of California, San Francisco). Radiology; 105: No. 1, 127-34 (Oct 1972).

Recovery (chiefly repair of sublethal radiation injury) was compared for a range of euoxic and hypoxic normal and tumor cells and tissues. A wide spectrum of recovery potential was found, ranging from none for the testes to low for lymphocytes, bone marrow, and thymic tumors, intermediate for normal lung, breast tumors, and sarcomas, and marked for skin, gut, and esophagus. Severe hypoxia reduced or eliminated recovery, particularly when applied during or between radiation doses. These factors support the use of hyperfractionated radiation therapy in many tumors. (auth)

59088 REPAIR AND LATENT INJURY IN RAT LIVER AFTER X-IRRADIATION. Witcofski, Richard L.; Pizzarello, Donald J.; Everhart, Hugh (Bowman Gray School of Medicine, Winston-Salem, N. C.). Radiology; 105: No. 1, 195-8(Oct 1972).

Young male rats were given single x-ray doses of 100, 250, or 500 rads to the liver, then partially hepatectomized at time intervals up to 12 weeks to study persistence of mitotic inhibition and chromosome aberrations. Mitotic inhibition was greater as the dose increased and animals took longer to return to control levels. Initial levels of chromosome bridges appeared to vary linearly with dose and to persist at these levels for time intervals related to the dose (3 weeks after 500 rads). After this time, the level of bridges fell to approximately one-half that initially seen with no further change observed. (auth)

59089 RBE OF PULSED RADIATIONS BY LETHALITY IN MICE: CULTURED MAMMALIAN CELLS AND BACTERIA. Antoku, Shigetoshi (Hiroshima Univ.). Radiat. Res.; 51: No. 3, 696-704(Sep 1972).

The biological effectiveness of 25-MV pulsed x-rays was compared with that of Co-60 γ-rays and 180 kVp x-rays in studies using ICR—JCL female mice, mouse L5178Y leukemic cells, and E. coli B$_H$ and H/r-30 bacteria. Relative biological effectiveness (RBE) of pulsed x-rays with the mortality of mice as an end point was 1.11 that of Co-60 γ-rays; the value for 180 kVp x-rays was 1.28. Patterns of daily mortality and body weight fluctuations of mice exposed to pulsed x-rays were similar to those of Co-60 γ-rays. RBE values obtained for cultured cells were the same as those listed above for mortality of mice. Changes in RBE by differences in cell phase between exponential and stationary growth were not observed for given radiations, although D$_0$ values and extrapolation numbers did vary by cell phase. However, the sensitivity of E. coli did not depend significantly on the type of radiation delivered. (auth)

59090 POSTIRRADIATION HIBERNATION AND RADIATION RESPONSE OF GROUND SQUIRRELS: TELEMETRY SURVEILLANCE. Barr, R. E.; Musacchia, X. J. (Univ. of Missouri, Columbia). Radiat. Res.; 51: No. 3, 631-7(Sep 1972).

Temperature sensitive radio transmitters were implanted in the abdominal cavity of ground squirrels, Citellus tridecemlineatus. A 72-channel telemetry receiver system was constructed to monitor the hibernation patterns, as reflected in body temperature changes, of 72 squirrels given 1250 rads ^{60}Co gamma radiation and 20 nonirradiated controls. Forty-eight squirrels were irradiated while torpid and 24 while active. These groups were equally divided into three postirradiation groups, one group each being maintained for 8 weeks at temperature environments, 5, 13, and 23°C. The results showed the highest levels of survival among squirrels irradiated while torpid and that additional increase in survival may have occurred due to postirradiation hibernation. No significant effect was noted relating to the three postirradiation environments. (auth)

59091 COMPARATIVE EFFECTS OF DOSE PROTRACTION BY FRACTIONATION AND BY CONTINUOUS EXPOSURE. Spalding, J. F.; Basmann, N. J.; Archuleta, R. F.; Johnson, O. S. (Los Alamos Scientific Lab., N. Mex.). Radiat. Res.; 51: No. 3, 608-14(Sep 1972).

Conclusions from high dose-rate fractionation studies, that mortality response can be effectively estimated solely from the dose and total-time interval of exposure alone, have been broadly interpreted to include a wide dose-rate range. The effects of continuous exposure were compared with those of relatively low dose-rate fractionation on mice, giving equal total doses over the same time span. Fractionated exposure proved to be significantly more biologically damaging than did continuous exposure. Mean after-survival times showed that continuously exposed mice survived approximately 40% longer than those exposed by the fractionation method. It was concluded that extrapolation of dose-rate data on the assumption that fractionation of dose is equivalent to continuous exposure, with time and total dose in each case being equal, is not warranted in all cases. (auth)

59092 RADIATION MORTALITY IN THE CHINESE HAMSTER, CRICETULUS GRISEUS, IN RELATION TO AGE. Ward, B. C.; Childress, J. R.; Jessup, G. L. Jr.; Lappenbusch, W. L. (Twinbrook Research Lab., Rockville, Md.). Radiat. Res.; 51: No. 3, 599-607(Sep 1972).

Chinese hamsters (Cricetulus griseus) were given whole-body x-radiation at 1, 3, 7, 15, 30, 71, 100, 150, and 250 days of age. Probit dose—mortality curves, $LD_{50(30)}$ values, and mean survival times were determined for each age. The $LD_{50(30)}$ values were lowest at 1 day of age (635 rads), increased rapidly to a peak of 983 rads at 100 days of age, and then decreased slightly to 910 rads at 150 and 250 days of age. The age sensitivity of the Chinese hamster was found to be similar to that of the rat but different from the age-sensitivity response of the mouse or dog. (auth)

59093 EXPOSURE-RATE RESPONSE IN THE PRENATALLY IRRADIATED RAT: EFFECTS OF 100 R ON DAY 11 OF GESTATION TO THE DEVELOPING EYE. Strange, John R.; Murphree, R. L. (UT—AEC Agricultural Research Lab., Oak Ridge, Tenn.). Contract AT-40-1-gen-242. Radiat. Res.; 51: No. 3, 674-84 (Sep 1972).

Previous work has shown irradiation on day 11 of gestation in the rat produces high frequencies of eye anomalies. An exposure—response curve established for the young of irradiated females revealed minimal eye damage at 50 R and near maximal damage at 150 and 200 R total exposure. An exposure of 100 R gave responses which involved only eye anomalies and therefore was chosen for a comprehensive exposure-rate study. Exposure rate of 0, 1, 2, 3.3, 5, 10, 25, and 47 R/min were used. Results revealed a rapid increase in eye damage up to 3.3 R/min with gradual, but not significant further increases at 5 and 10 R/min. Exposure rates of 25 and 47 R/min showed significantly fewer defects than the 3.3, 5, and 10 R group complex. (auth)

59094 MECHANISM OF THE ORIGIN OF CORTICAL SLOW AFTERDISCHARGE DURING RADIATION INJURY OF THE BRAIN. Nadareishvili, K. Sh.; Bakradze, O. S.; Dashniani, M. G.; Sandodze, V. Ya. (Inst. of Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 68: No. 1, 189-92(Oct 1972). (In Russian).

Some physiological properties of the so-called cortical slow afterdischarge (SAD) to photic stimuli were studied in unanesthetized rabbits during exposure to different parts of the body including hemilateral x irradiation of the brain. The SAD was found to arise in all cases except for the body irradiation (head shielding) with a dose of about 8 to 14 krads. The available physiological data and a comparative analysis allow to conclude that the SAD development is mainly accounted for by radiation injury of the mesencephalic reticular formation. (auth)

59095 EFFECT OF WHOLE BODY X-IRRADIATION ON EXPERIMENTAL ALLERGIC ENCEPHALOMYELITIS IN THE RAT. Visakorpi, R.; Kosunen, T. U. (Univ. of Helsinki). Ann. Med. Exp. Biol. Fenn. (Helsinki); 50: No. 2, 95-7(1972).

High doses of irradiation had only a moderate suppressive effect on the development of experimental allergic encephalomyelitis in rats. With the highest irradiation dose (800 rads) given 1 day before immunization, the onset of disease was delayed from the 12th day (nonirradiated controls) to the 24th day. In animals irradiated after immunization, but before the onset of symptoms, a delay in onset was also found. This was correlated with the size of the irradiation dose. The number of paralyzed rats was also smaller than in the nonirradiated group. (auth)

59096 EVOLUTION OF THE LYMPHOCYTIC CHROMOSOME ABERRATIONS IN IN VIVO ^{60}Co IRRADIATED PIGS. Haag, J.; Gacevio, M.; Nizza, P. (CEA, Jouy-en-Josas, France). Ann. Genet. (Paris); 15: No. 1, 5-10(1972). (In French).

Six pigs were irradiated with ^{60}Co (165 rads in the median plane). It was demonstrated that for identical exposures (285 R in air), the chromosome aberration (dicentrics and rings) frequency is similar for in vitro and in vivo irradiated blood. These aberrations decrease very rapidly, reaching a relatively constant level after 15 weeks (8% of the initial frequency) which remains unchanged for a period of 25 weeks. (France)

59097 CHANGES IN THE CONTENT OF SEROTONIN IN THE HYPOTHALAMUS OF RATS AT REMOTE PERIODS AFTER IRRADIATION. Prokudina, E. A.; Bazanova, N. V.; Svetlova, M. P. (Central Research Inst. of Roentgeno-Radiology, Leningrad). Byull. Eksp. Med. Biol.; 74: No. 8, 34-6(Aug 1972). (In Russian).

There was revealed a significant reduction in serotonin level in rat hypothalamus 6 to 12 months after x irradiation of these animals in a dose of 460 R. A change in serotonin content was not the result of direct irradiation, since at early periods after the exposure its concentration failed to differ from the control. A change of serotonin level in the hypothalamus exhibited a definite correlation with the state of the hypophysial-adrenal system at the remote post-irradiation periods. (auth)

59098 PRIMARY REACTION OF THE HYPOPHYSEO-ADRENOCORTICAL SYSTEM ON THE ACTION OF IONIZING RADIATION. Romashko, O. O.; Rogozkin, V. D. Byull. Eksp. Med. Biol.; 74: No. 8, 23-5(Aug 1972). (In Russian).

A primary reaction of the hypophyseo-adrenal system in response to irradiation in doses of 650, 850, and 1000 R was studied. Primary reaction of activation of hormone formation and secretion in the adrenal glands of irradiated rats was biphasic during the first hr after the irradiation. The first phase of the early reaction was expressed 1 to 5 hr after the total irradiation with all the ionizing radiation doses under study. The first phase of the early reaction is supposed to be a nonspecific stressor reaction, and the second a specific reaction to irradiation caused by disturbances occurring during the latent period of radiation disease. (auth)

59099 INVESTIGATIONS ON POST-RADIATION HYDROLYTIC ACTIVITY OF ISOLATED PERFUSED LIVER. PART I. Kocmierska-Grodzka, D. (Medical Academy, Bialystok, Poland). Strahlentherapie; 143: No. 6, 705-10(Jun 1972).

The hydrolytic activity in isolated perfused liver of rats whole-body irradiated with a lethal dose of x rays was investigated. The lysosomal markers β-glucuronidase activity parallel with the potassium and lipid peroxides concentration were evaluated 24 hr after irradiation. In the course of perfusion, it was stated greater increase of the specific activity of β-glucuronidase in perfusate and lysosome-mitochondrial fraction of irradiated livers than in control ones. At the end of perfusion, the increased amount of lipid peroxides in lysosome-mitochondrial fraction of irradiated livers in comparison to controls was found. This was accompanied by some signs of hyperpotassemia in the tissue of irradiated livers. The observed post-radiation increase of hydrolytic activity of perfused liver is discussed in terms of the post-radiation damage of lysosomal barriers. (auth)

59100 HISTOMETRIC STUDY OF ACUTE RADIATION EFFECTS ON RAT TAIL EPIDERMIS. de Rey, B. L. M.; Klein-Szanto, A. J. P. (Comision Nacional de Energia Atomica, Buenos Aires). Strahlentherapie; 143: No. 6, 699-704(Jun 1972).

Histometric techniques are applied to the study of acute radiation effects, otherwise difficult to evaluate. Their application to rat tail epidermis x-irradiated with 2, 4, 8, and 16 krad reveals that dose and post-irradiation time directly affect epithelial thickness, dispersion of its values, and the number of epithelial cells. A mathematical and statistical evaluation of these findings supports the possibility of adopting this quantitative technique for acute radiation damage evaluation. (auth)

59101 HISTOLOGICAL EXAMINATIONS ON THE REGENERATION OF GASTRIC INJURIES CAUSED BY EXPERIMENTAL FRACTIONATED LOCAL X-RAY TREATMENT. Kovacs, L. Strahlentherapie; 143: No. 6, 686-98(Jun 1972). (In German).

The author applied local irradiations in 16 fractions to a total of 8000 R to the stomach of white rats and examined the course of regenerative processes by histological and histochemical methods. According to this observation, the glandular epithelium is nearly completely destroyed under the influence of 8000 R. The squamous epithelium of the stomach remains mostly unchanged. The regeneration of the glandular epithelium primarily proceeds from this squamous epithelium as well as from single cells of remaining glands. The regenerated glands initially are atypical; later only regular fundus glands develop. By the 15th day, all the ulcers have disappeared, but the regeneration is not yet complete. Many fundus glands show an atypical, irregular structure with abnormal cystic dilatation. (auth)

59102 ROLE OF THE ROUTE OF ADMINISTRATION OF 5-METHOXYTRYPTAMINE IN ITS PROTECTIVE EFFECTS ON THE HAEMATOPOIETIC STEM CELLS OF IRRADIATED MICE. **Vacek, A.; Rakova, A.; Rotkovska, D.; (and others) (Inst. of Biophysics, Brno). Strahlentherapie; 143: No. 6, 677-85(Jun 1972).**

The protective effect of 5-methoxytryptamine (5-MOT) on the hematopoietic stem cells in mice, as dependent on the dose of 5-MOT, route of administration, and the time interval between its application and irradiation, was studied. After the intraperitoneal and per os application of 5-MOT, the highest protective effect was registered within the first 15 min after the injection; thereafter a decrease occurred. On the other hand, after the subcutaneous application of 5-MOT a higher protective effect on the blood formation was observed within 30 to 60 min after the injection. Within 10 min after the application of 5-MOT, the oxygen tension in tissues dropped to 10% of the original level and then persisted for more than 1 hr. (auth)

59103 ABOUT THE SIGNIFICANCE OF GLUTATHION IN THE RADIATION EFFECT AND IN THE CHEMICAL RADIATION PROTECTION. **Rathgen, G. H.; Lieser, H. (Univ., Mainz). Strahlentherapie; 143: No. 6, 670-6(Jun 1972). (In German).**

Exposure of the whole body of rats with 800 R x radiation leads to a quick decrease of the glutathion level in the blood, with concomitant increase of glutathion disulfide. At the same time in the liver, spleen, and kidney of the animals an augmentation of glutathion is found, whereas the disulfide is diminished in these organs. Cysteine (140 mg per kg body weight), applied intraperitoneally before exposure, can abolish the changes of the GSH- and GSSG level. In this case, the GSH level of the blood is augmented even up to 120 min after irradiation. (auth)

59104 EFFECT OF HYDROCORTISONE PRETREATMENT UPON ERYTHROPOIETIC RECOVERY AFTER A SINGLE SUBLETHAL X-RAY EXPOSURE OF MICE (^{59}Fe UPTAKE/ENDOGENOUS SPLEEN COLONIES/PRE-IRRADIATION STRESS). **Pospisil, M.; Zakopalova, Iva; Netikova, Jaromira (Inst. of Biophysics, Brno). Folia Biol. (Prague); 18: No. 4, 284-91(1972).**

As part of a broader study into the mechanism of modification of radiation resistance by pre-irradiation stress, the effect of hydrocortisone pretreatment upon the recovery of erythropoietic activity was studied in mice exposed to 200 R, 300 R, and 450 R. The measurements of ^{59}Fe uptake in blood-forming organs (spleen and femoral bone marrow), as well as ^{59}Fe incorporation in newly formed erythrocytes released into the periphery demonstrated that two daily doses of hydrocortisone stimulated erythropoietic recovery in the bone marrow of animals irradiated on days 3 and 5 after the treatment. Splenectomy did not alter the stimulatory action of hydrocortisone pretreatment. Endogenous spleen-colony formation after 450 R was inhibited by hydrocortisone preceding the radiation exposure by 1 or 3 days. The effect of hydrocortisone on bone marrow erythropoietic recovery is probably due to the stimulation of erythroid stem cell formation, increasing the capacity of bone marrow to recover from ensuing radiation damage. (auth)

59105 RESPONSES OF BONE MARROW AND TUMOR CELLS TO ACUTE AND PROTRACTED IRRADIATION. **Frindel, Emilia; Hahn, George M.; Robaglia, Daniele; Tubiana, Maurice (Inst. Gustave-Roussy, Villejuif, France). Cancer Res.; 32: No. 10, 2096-2103(Oct 1972).**

Mice bearing NCTC 2472 tumors (either solid or ascitic) were continuously irradiated at 50 rads/hr in order to simulate a dose rate comparable to that generated by tissue implants. Kinetic and survival data were collected over a 40-hr interval on cells obtained from tumors and also from bone marrow. Bone marrow cellularity decreased rather slowly. At 40 hr, it was 10% of the control value. The number of stem cells was reduced much more rapidly; after only 12 hrs it was reduced to 3.8% of the control value. The effectiveness of continuous radiation and of acute irradiation on bone marrow stem cells is similar. Labeling indices decreased with increasing time of irradiation; the mitotic indices dropped initially but tended to recover. Under continuous irradiation, the ascites cells accumulated in G_2 at a rapid rate. After 40 hr, 61% of the cells were in G_2 phase (versus 5% in the controls), whereas after an acute irradiation cells temporarily accumulated in G_1 phase. The time interval during which this accumulation is observed is dose dependent. Survival curves of cells from solid tumors show no evidence of hypoxic cells down to a survival level of 10^{-3}; cells from acutely irradiated tumors yielded biphasic survival curves with 10 to 20% of the cells hypoxic. The difference in the effectiveness of continuous and acute irradiation on NCTC solid tumor cells is small. (auth)

59106 COMPENSATORY RESPONSE OF THE INTESTINE TO LACTATION: THE EFFECT OF IRRADIATION. **Sigdestad, Curtis P.; Osborne, James W. (Univ. of Louisville, Ky.). Growth; 36: No. 3, 165-71(Sep 1972).**

The compensatory changes occurring in the intestine of virgin, non-lactating primiparous, and lactating rats were studied. The wet and dry weights of the duodenum and the ileum-jejunum were the parameters tested. The effect upon these parameters of the number of newborns nursing and the length of time nursing was also studied. The survival times of x-irradiated male, virgin female, primiparous, and lactating females (16 days) were also determined. No significant difference was noted in any parameter tested for the virgin or primiparous groups. Generally, the lactating groups showed a significant increase in wet and dry weights. The increase was greater with longer nursing times and with larger numbers of newborns nursing. The compensatory intestinal changes did not affect the survival time of rats whose ileum and jejunum were exposed to 1500, 2500, or 3000 R of x radiation. (auth)

59107 DAMAGE OF THE SKIN DURING THE ACUTE GRAFT-VERSUS-HOST REACTION IN MICE. **Boranic, M.; Orsanic, L.; Blazi, M. (Rudjer Boskovic Inst., Zagreb). Transplantation; 14: No. 4, 442-7(Oct 1972).**

Mice were irradiated with a sublethal dose of x rays and injected with allogeneic lymph node, thymus, or bone marrow cells to induce an acute graft-versus-host (GVH) reaction. Pieces of their skin taken 4, 5, 6, 7, or 8 days later were grafted onto normal syngeneic mice, syngeneic mice immunized against cells causing GVH reaction, syngeneic mice deprived of thymus, or F_1 hybrid recipients, and were observed for the extent of acceptance. The grafts in all groups of recipients healed in and became vascularized, but after 1 week or so deteriorated and many of them sloughed off completely. The skin was particularly liable to be rejected if taken 6 or 7 days after irradiation and injection of allogeneic cells. The rejection of grafts was attributed to: reaction of recipients of the grafts against allogeneic cells that have infiltrated the skin in the donor chimera, and inherent damage of the skin because of irradiation and continued function of infiltrated cells. (auth)

59108 LIPID FRACTIONS OF SERUM AND LIVER AFTER X-RAY IRRADIATION OF THE LIVER WITH 4000 R. **Soltesz, L.; Gottwald, Gizella (Semmelweis Univ., Budapest). Acta Med. Acad. Sci. Hung.; 28: No. 3-4, 287-93(1971).**

The lipid fractions in blood serum and in the liver were studied in rats after local administration of 4000 R to the liver. While in the first week after irradiation no significant change in the serum lipid components was demonstrable, the cholesterol concentration in the liver showed a significant decrease. This, however, proved reversible, the normal values being restored by the 42nd day. The phospholipids and esterified fatty acids remained unaffected in the liver, while in the serum the phospholipids increased significantly from the 7th, the esterified fatty acids from the 10th, and cholesterol from the 28th day onward. The fall in liver cholesterol during the first 42 hrs after irradiation may be attributed to a direct injury to the organ. The rise in the serum lipid level at later stages suggests an involvement of additional factors. (auth)

59109 RECOVERY OF HAEMOPOIESIS IN LETHALLY IRRADIATED MONKEYS BY FROZEN ALLOGENEIC BONE MARROW GRAFTS. **Schaefer, U. W.; Dicke, K. A.; Van Bekkum, D. W. Rev. Eur. Etud. Clin. Biol.; 17: No. 5, 483-8(May 1972).**

In mice, it was observed that after the thawing of frozen hemopoietic cells, stepwise dilution greatly increased the reproducibility of an optimal stem cell recovery. The CFU (in vitro) assay and the CFU (in vivo) assay were used. Similarly in monkeys, stepwise dilution after the thawing of marrow frozen in DMSO and calf serum preserved to the maximum its proliferation capacity as measured by the thin layer agar technique. With the help of this in vitro assay, the dilution method was improved for handling stored monkey bone marrow. Frozen allogeneic bone marrow cells stepwise diluted after thawing were able to restore the hemopoiesis of lethally irradiated Rhesus monkeys. Reproducible takes were obtained by grafting limited cell numbers (4×10^8/kg) that were the same as the amount of fresh bone marrow cells necessary for hemopoietic repopulation. The results obtained indicate that in monkeys, bone marrow cells can be frozen and thawed without loss of proliferation capacity if the cells are diluted gradually and an osmotic shock avoided. (France)

59110 CYTOTOXIC EFFECT OF A XENOGENEIC ANTISERUM ON BONE MARROW CELLS FROM NORMAL OR SUB-

LETHALLY IRRADIATED MICE. Haot, J. (Univ., Liege); Moeller, Erna; Hiesche, K.; Revesz, L. Experientia; 28: No. 8, 956-7 (15 Aug 1972).

A rabbit was given three intravenous injections of embryonic mouse cells at 14 day intervals; the rabbit was bled one week after the last injection. Bone marrow cell suspensions were prepared from femurs of mice which were unirradiated or irradiated with 400 R x rays 12 days earlier. For cytotoxicity tests aliquots of the suspension were incubated with serially diluted serum for 1 hr, and controls were prepared without serum. An estimation was made of the percentage of viable cells when cells from normal or preirradiated marrow were exposed to the rabbit antiserum. The data suggested that the rabbit antiserum produced against embryonic mouse tissues contains antibodies active against a part of the cell population present in the bone marrow of irradiated mice but not in that of untreated mice. (H.L.W.)

59111 CHANGE IN SIZES OF STOMACH PLEXUS NERVE CELLS IN RESPONSE TO TOTAL X IRRADIATION. Tkachenko, Z. Ya.; Sitnyans'ka, N. P. (Inst. of Microbiology and Virology, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR; 18: No. 3, 385-90 (1972). (In Ukrainian).

The investigations carried out showed that single x-ray irradiation of rabbits in a dose of 1400 R results in changes in the stomach plexi with a strict correlation between the sizes of nerve cells, nuclei, and morphological characteristics. Simultaneously with injury and death of the neurons, reparative processes are detected in the plexus. (auth)

Invertebrates

Refer also to abstracts 58991 and 59029.

59112 TRANSMUTATION OF ^{14}C WITHIN DNA OF DROSOPHILA MELANOGASTER SPERMATOZOA. Lee, William R.; Sega, Gary A.; Benson, E. Sky (Louisiana State Univ., Baton Rouge). Contract AT(40-1)-3728. Mutat. Res.; 16: No. 2, 195-201(Oct 1972).

Transmutation of ^{14}C to ^{14}N within the thymidine moiety of DNA in Drosophila melanogaster spermatozoa was studied. To separate any transmutation effect from the known genetic effect of the accompanying beta radiation, ^{14}C-labeled spermatozoa were stored in unlabeled females under conditions of sufficient dilution to give insignificant radiation from other labeled sperm cells and seminal fluids. There was also minimal absorption of beta radiation from beta decay within each cell as most ionizations occurred beyond the limits of the thin cylindrical Drosophila sperm cell ($0.3\ \mu \times 9\ \mu$). Therefore, we were able to label with a dose higher than the lethal limit in a generally labeled experiment. Our highest dosage was obtained by pulse labeling larvae with uniformly labeled [^{14}C]thymidine and produced a total of 600 ^{14}C disintegrations per sperm cell or 80 per Y- or X-chromosome euchromatin during a 3-week storage period in unlabeled females. The following genetic tests were conducted: (1) loss of a dominant marker on the Y-chromosome that could result from breakage followed by loss of the chromosome tip to loss of the entire chromosome; (2) sex-linked recessive lethals observed in the F_2, F_3, and F_4. All of these genetic tests were negative in that they showed no significant increase in the mutation rate in progeny from sperm stored for 3 weeks over progeny from unstored sperm cells. In a previous experiment with transmutation of ^{32}P we obtained positive results in the F_3, a consequence of F_1 females with mosaic gonads. The negative results in the present experiment with ^{14}C could be due to the lower energy of the recoil nuclide or to position within the DNA molecule. That 80 ^{14}C disintegrations in the DNA per X- or Y-chromosome did not produce a detectable genetic effect is evidence for the stability of the eukaryote chromosome and the efficiency of its repair systems. (auth)

59113 CHARACTERIZATION OF REPAIR MECHANISMS OPERATING SUBSEQUENT TO GENETIC DAMAGE INDUCED BY ETHYL METHANESULFONATE AND GAMMA RADIATION IN BRACON HEBETOR. Hoffman, Albert C. (Millersville State Coll., Pa.). Mutat. Res.; 16: No. 2, 175-88(Oct 1972).

This investigation utilized females of the parasitic wasp Habrobracon juglandis (Ashmead) = Bracon hebetor Say to study the biological and biochemical processes involved in the modification of genetic damage induced by a chemical and a physical mutagen, ethyl methanesulfonate (EMS) and gamma radiation, respectively. The hatchability of metaphase–prophase oocytes improved when EMS-injected females were temporarily prevented from ovipositing by withholding hosts. Storage following 2000 R gamma radiation also resulted in improved hatchability. Repair processes appear to take place during storage of mature oocytes. Mature oocytes ready for deposition are halted in metaphase I of meiosis. Unfertilized eggs routinely produce haploid males. In this organism the oviposition process, rather than sperm penetration, is considered the developmental stimulus. Storage without hosts following mutagenic treatment postpones development and apparently provides optimum conditions for repair. If, however, the mitotic divisions of cleavage begin immediately following mutagenic treatment, then the repair processes have not had sufficient time to correct genetic damage and cannot do so during development. This was reflected in the higher hatchability of stored oocytes. The physical and chemical environments of the egg during storage were modified and conditions necessary for repair were determined. Inhibition studies following EMS treatment demonstrated that low temperature, low oxygen concentration, 2,4-dinitrophenol, and reduced glutathione inhibited repair. Radiation repair was also inhibited by low oxygen, low temperature, and dinitrophenol. Deoxyadenosine, chloramphenicol, copper sulfate, and two reducing agents were not effective inhibitors. Negative results were also obtained with two enzyme inhibitors, p-hydroxymercuribenzoate and N-ethylmaleimide. An identical ''error-correcting mechanism'' may be involved in the repair of radiation and chemically induced genetic damage. (auth)

59114 INFLUENCE OF SOME ENVIRONMENTAL FACTORS N THE GROWING AND DEVELOPMENT OF SILK-WORMS TREATED WITH GAMMA-IRRADIATIONS IN THEIR EMBRYO-PHASE. Adler, Alexandrina. Zooteh. Med. Vet.; 12: 145-51(1969). (In Rumanian).

In view of reducing the growth rate of summer grown silkworms, gamma irradiations were tried in their embryonic state. The larva born from the irradiated semen were divided into two groups grown at a room temperature of maximum 30°C in one group and of maximum 27°C in the other. Each room contained an experimental and a control (non-irradiated) group. It was showed that the irradiated lot, grown at a temperature of 30°C (A treatment) was more resistent to illnesses as compared to the lot grown in a 27°C temperature (R treatment) which from this point of view was superior even to the controls. The explanation might be due to the growth inhibition caused by the irradiation of the semen, compensated by the effect of the high ambient temperature. Because of the reduced chrysalide weight of the irradiated and heat grown larvae, the silk percentage of the irradiated lot (A treatment) has sensibly surpassed the value of this index as compared to the other lots. It is concluded that the irradiation of the semen could be used to obtain optimal morpho-productivity indexes for the silkworms grown in the summer at high temperatures, unbearable to the nonirradiated worms. (auth)

59115 CONTROL OF THE MEDITERRANEAN FRUIT FLY (CERATITIS CAPITATA) USING STERILE MALES. EFFECTS OF NITROGEN AND CHILLING DURING GAMMA-IRRADIATION OF PUPARIA. Langley, P. A.; Maly, H. (Institut Atomic Energy Agency, Vienna). Entomol. Exp. Appl.; 14: No. 2, 137-46 (1971).

Flies were held for 15 min at 4° in air prior to irradiation at 4 or 25° by 10 or 30 kilorads of γ-rays from a ^{60}Co source. Other groups were held and irradiated at 4 or 25° in a N atm. Surviving males were subsequently kept in cages with virgin females and the eggs collected at intervals on foam rubber. The eggs were placed in closed petri dishes for 5 days of incubation at 25° and the egg hatch recorded. The protective effect of N was substantiated; but none was observed after cooling. Fertility was lowest when the pupae were treated in air at 4°, highest when irradiation occurred at 25° under N. After 30 kilorads at 25°, 1% fertility was recorded. Total sterility could be attained when combining cooling and irradiation. (auth)

59116 PHEROMONE RESPONSE OF GAMMA-IRRADIATED CABBAGE LOOPERS IN THE FIELD. Stimmann, M. W.; Wolf, W. W.; Toba, H. H. (Dept. of Agriculture, Riversie, Calif.). J. Econ. Entomol.; 65: No. 5, 1496-8(Oct 1972).

Procedures for marking, irradiating, trapping, and releasing the insects are described. Tables are presented to show the percent recovery of irradiated 3- to 7-day old male cabbage loopers in traps baited with synthetic pheromone and numbers of male cabbage loopers captured in traps baited with gamma-irradiated female cabbage loopers. Results indicated that the response to synthetic pheromone of male cabbage loopers that were either partially or completely sterilized with gamma radiation was not significantly reduced. Furthermore, the ability of gamma irradiated female cabbage loopers to attract native male moths was not reduced by treatment. (H.L.W.)

59117 INHERITANCE OF RADIATION-INDUCED PARTIAL STERILITY IN THE INDIAN MEAL MOTH. **Ashrafi, Shahid H.; Tilton, Elvin W.; Brower, John H. (Dept. of Agriculture, Savannah). J. Econ. Entomol.; 65: No. 5, 1265-8(Oct 1972).**

Fifth-stage larvae and adult males of Plodia interpunctella (Hübner) were subjected to doses of gamma radiation sufficient to produce partially sterile populations. Radiation of 5th-stage larvae at 3.5 krad caused a 72% reduction in numbers of offspring in the F_1 generation compared with numbers produced by unirradiated crosses. When F_1 males from this treated line were mated with normal females, there was an 89% reduction in the F_2 generation. Males treated with 3.5 krad as 5th-stage larvae were sexually competitive with normal males. When one-day-old adult P. interpunctella males were irradiated at various dose levels, irradiation of adults at 25 krad did not produce results comparable with those produced by the 3.5-krad radiation of the 5th-stage larvae. Dosages above 25 krad reduced the sexual competitiveness of the males treated as adults. (auth)

59118 INHERITED STERILITY IN THE F_1 PROGENY OF IRRADIATED MALE PINK BOLLWORMS. **Cheng, Wen-yi; North, David T. (Dept. of Agriculture, Fargo, N. Dak.). Contract AT(49-7)-3028. J. Econ. Entomol.; 65: No. 5, 1272-5(Oct 1972).**

When individual P_1 male Pectinophora gossypiella (Saunders) were treated with 20 krad of gamma irradiation and paired with normal females, the sex ratio of the resulting F_1 adults was 4 males to 1 female, and the F_1 males were not competitive. When males were treated with 15 krad, the sex ratio of the F_1 adults was about 2 males to 1 female. Most of these F_1 males mated and transferred sperm, but the sperm mixture was abnormal; in half the matings, eupyrene sperm was lacking. As with many other species of moths, the F_1 males were more sterile than the irradiated male parent. (auth)

59119 STERILITY INDUCED IN TOBACCO BUDWORMS BY COMBINATION OF RESERPINE AND GAMMA IRRADIATION AFFECTED BY AGE AND SEX OF PUPAE. **Guerra, A. A. (Dept. of Agriculture, Brownsville, Tex.). J. Econ. Entomol.; 65: No. 5, 1282-3(Oct 1972).**

Female Heliothis virescens (F.) were sterilized completely when pupae from larvae reared on diets containing reserpine (0.1% wt/v) were exposed to 7.5, 10, 15, or 20 krad of gamma irradiation; mating frequency and longevity of resulting adults were unaffected. Although egg hatch was inhibited completely when females reared on reserpine were irradiated as 2-, 4-, 6-, and 8-day-old pupae and crossed with untreated males, some hatch occurred when they were irradiated as 10- to 12-day-old pupae. Males were not sterilized completely by the combinations of treatment (egg hatch was never inhibited completely), but when young male pupae were irradiated, the percentage egg hatch was more reduced than when older pupae were treated. (auth)

59120 STERILIZATION OF ADULT FALL ARMYWORMS BY GAMMA IRRADIATION AND ITS EFFECT ON COMPETITIVENESS. **Snow, J. Wendell; Young, J. R.; Lewis, W. J.; Jones, R. L. (Dept. of Agriculture, Tifton, Ga.). J. Econ. Entomol.; 65: No. 5, 1431-3(Oct 1972).**

The quantity of ^{60}Co irradiation necessary to sterilize adult male Spodoptera frugiperda (J.E. Smith) was established at 35 krad, while a dose of 15 krad sterilized the female. In laboratory and field tests, sterilizing doses did not alter the lifespan of the adults, ability of the female to attract the male, ability of the male to seek the female, or ability of the adults to copulate. However, sterilization significantly reduced the oviposition rate of sterile females and the type and quality of sperm transferred by sterile males. These adverse effects were reflected in reduced egg hatch. The data indicate that sterilized males are approximately 0.46 times as competitive as normal males. (auth)

59121 INFLUENCE OF IONIZING IRRADIATION ON INFECTIVITY OF EGGS OF ECHINOCOCCUS GRANULOSUS IN LABORATORY RODENTS. **Williams, J. F.; Colli, Cristina W. (Pan American Health Organization, Buenos Aires). J. Parasitol.; 58: No. 3, 427-30(Jun 1972).**

Eggs of Echinococcus granulosus were subjected to x-irradiation at levels of 5, 10, 20, or 30 kr, and its influence on their infectivity in laboratory rodents was measured. A dose of 10 kr was sufficient to produce a significant reduction in the number of cysts developing from the embryos in each animal inoculated intraperitoneally with 15-day-old eggs. Doses of 20 and 30 kr had an inhibitory effect on both the number of animals becoming infected and the number of cysts formed. Eggs stored for 60 days were less susceptible to x-irradiation than those stored for 15 days prior to exposure. Eggs exposed to ultraviolet irradiation for 24 hr showed a marked reduction in infectivity for mice. No animals became infected after receiving 500 ultraviolet-irradiated eggs. Even in animals receiving 2,000 ultraviolet-irradiated eggs the number developing into cysts was significantly reduced compared to the controls. The findings are discussed in relation to available information on the effects of ionizing irradiation on cestode tissues and eggs. (auth)

59122 EFFECT OF ULTRAVIOLET RADIATION ON THE CELL CYCLE DURATION AND PHOTOACTIVATION PHENOMENA OF TETRAHYMENA PYRIFORMIS. **Caratero, C.; Caratero, A.; Planel, H.; Cubaynes, A. M. (Univ., Toulouse). Compt. Rend. Soc. Biol.; 165: No. 11, 2194-7(1971). (In French).**

Tetrahymena pyriformis were irradiated with 253 nm uv radiation. These organisms were irradiated in the presence of white or yellow light. The irradiation time was between 30 and 75 min, the total doses being respectively 17 ergs/mm^2 and 44 ergs/mm^2. Irradiation effected at the beginning of the cycle and during a further 75 min led to a 44% increase in the relative duration of the cycle. Irradiation effected during 30 min after the beginning of the cycle led to a 19% increase. Irradiation effected during 30 min after the beginning of the cycle led to a 14% increase in the relative cycle duration. In addition, the use of white light, as opposed to yellow light, demonstrated the existence of a reactivation phenomenon. (France)

59123 NITROGEN PRETREATMENT PERIOD REQUIRED FOR COMPLETE ELIMINATION OF THE OXYGEN EFFECT IN X-RAYED DROSOPHILA EMBRYOS. **Wuergler, F. E.; Ulrich, H. (Swiss Federal Inst. of Tech., Zurich). Experientia; 28: No. 8, 895-6(15 Aug 1972).**

Fifteen min old eggs of Drosophila were collected and pretreated with purified nitrogen for periods of time ranging from 0 to 60 sec in a plexiglas chamber. A 2000 R dose of x radiation was applied within 1 sec and percentages of embryonic lethality were tabulated. It was found that a pretreatment period of only 15 sec was sufficient to achieve complete anoxia. (H.L.W.)

Radionuclide Effects (Internal Source)

Man

59124 NEW METHODS FOR CALCULATION OF ABSORBED DOSE FROM RADIOPHARMACEUTICALS. **Husak, V. (Univ. Hospital, Olomoue, Czech.). Radiobiol.-Radiother.; 13: No. 4, 459-69(1972).**

Comparison is made of methods for computing the absorbed dose and attention is called to some discrepancies existing even in the latest data reported by MIRD. In agreement with other authors, it is recommended to abandon the older methods of the calculation, mainly the ICRP method and that based on the geometrical factors. In order to make calculations of the absorbed dose simpler, the use of the tabulated values of a total absorbed dose constant, analogous to the ICRP concept of the effective energy, is suggested. (auth)

59125 DOSE DISTRIBUTIONS ABOUT ^{137}Cs SOURCES IN TISSUE. **Krishnaswamy, V. (Albert Einstein Coll. of Medicine, Bronx, N. Y.). Radiology; 105: No. 1, 181-4(Oct 1972).**

Calculations of depth doses about ^{137}Cs sources prove that the cesium depth dose data differ from those for equivalent radium sources at oblique points beyond the active length because of the difference in filtration between the steel and the platinum walls. The variations of the depth dose ratio of cesium over radium normalized at a fixed point in tissue are presented. Tables of depth dose data for commercially available ^{137}Cs sources are given. (auth)

59126 RADIOPHARMACEUTICALS: STUDIES RADIATION PENETRATION IN SIMULATED BODY TISSUES. **Chimia (Aarau); 26: No. 9, 484-5(15 Sep 1972).**

Radiopharmaceuticals used in medicine pose a certain radiation health hazard. A continuing program is underway at the National Bureau of Standards, Washington (NBS) to assist the medical field by determining the energy distribution of beta particles and gamma rays in simulated body tissue. These absorbed dose distributions help radiologists weigh the benefits and risks encountered with the use of radiopharmaceuticals. (auth)

Animals

Refer also to abstract 59045.

59127 CELL DIVISION AND REGENERATIVE PROCESSES IN THYROID GLAND IRRADIATED WITH RADIOACTIVE IODINE. Romanov, Yu. A. (Moscow Medical Inst.). Zh. Obshch. Biol.; 33: No. 4, 397-408(1972). (In Russian).

Iodine-131 irradiation of thyroid gland at damaging dosages brought about sharp disturbances of cell reproductive and regenerative processes. The effect of "radiothyroidectomy" proved to be much more drastic than that of surgical ablation of a part of the gland after which pronounced regeneration phenomena are developing. The final results of regeneration processes in ^{131}I-irradiated gland depend on a number of factors among which submicroscopic and metabolic changes in thyreocytes, disturbances of the secretory process, the vascular degeneration and thrombosis, the damage of the gland nervous apparatus, radioresistance, and proliferation of the mitotic cycle and chromosome apparatus of the thyroid cells are noted. The formation of gland tumor after ^{113}I incorporation is closely associated with the disturbance of cellular proliferation in the organ under consideration and augmentation of its functional activity. A dissimilar capability of proliferation in cells of different follicles plays an important role in this process. (auth)

59128 DOSE TO OSTEOGENIC CELLS FROM ^{239}Pu DEPOSITED IN RAT BONE. James, Anthony C. (Royal Free Hospital School of Medicine, London). Radiat. Res.; 51: No. 3, 654-73 (Sep 1972).

Six to eight- week-old Marshall-August rats were given a single iv injection of 4.5 μCi/kg soluble $Pu(NO_3)_4$, a dose-level expected to give an approximately 80% yield of osteosarcomas. Localized dose-rates were measured at fixed reference distances between 5 and 20 μm from bone surfaces by counting α-flux entering small cylindrical targets located in a thin nuclear emulsion in contact with a bone section. Dose-rates 1 day after the injection ranged from 22 to 57, 12 to 37 and 7 to 26 rads/day at distances of 5, 12.5 and 20 μm, respectively, from a number of different endosteal surfaces selected for measurement. These local dose-rates changed with time by factors of the order of 2, in either direction, depending on the prevailing conditions of remodeling. Histological evidence of preferred sites for the development of osteosarcomas is discussed in relation to local α-dose. A cumulative α-dose of about 2000 rads (delivered to primitive cells at trabecular surfaces over a period of 36 wk) may be associated with a 10% probability of developing a tumor in an individual femoral epiphysis. (auth)

Plants

Refer also to abstracts 59023 and 59031.

Microorganisms

59129 INDUCTION OF RECOMBINATION BY DECAY OF ^{32}P INCORPORATED INTO ONE OR TWO GENOMES OF YEAST ZYGOTE. Korolev, V. G.; Gracheva, L. M. (Ioffe Inst. of Physics and Tech., Leningrad). Genetika; 8: No. 8, 111-20(Aug 1972). (In Russian).

Experiments on the induction of recombination in yeast zygotes with one and two ^{32}P-labeled genomes were carried out. It is shown that ^{32}P decay caused mitotic recombination. This induction of recombination is more effective in zygotes with two labeled genomes than in zygotes with one labeled genome. Results of genetic analysis showed that the mitotic recombination in zygotes was the result of crossing-over, double crossing-over (reciprocal recombination), and gene conversion (non-reciprocal recombination). The reciprocal recombination took place more often in zygotes with two ^{32}P-labeled genomes than in zygotes with one ^{32}P-labeled genome. The possibility of repair of double stranded breaks in DNA using mitotic recombination is discussed. (auth)

Nuclide Kinetics and Toxicology

59130 FIXATION MECHANISM OF ISOTOPES OF THE RARE-EARTH ELEMENTS BY INDIVIDUAL SKIN STRUCTURES. Shvydko, N. S.; Il'in, L. A.; Noretz, R. A.; Antonova, V. A. (Leningrad Scientific-Research Inst. of Radiation Hygiene). Gig. Sanit.; No. 6, 43-7(Jun 1972). (In Russian).

Data are presented on the quantitative distribution of ^{141}Ce, ^{144}Ce, ^{143}Pr, ^{97}Y, and ^{147}Nd in skin structures and its various layers. On the basis of the results obtained, the uptake of radionuclides entering the skin is subjected to a comparative analysis. (auth)

Man

Refer also to abstracts 58812, 59053, and 59061.

59131 (CEA-BIB-203) SURGICAL TREATMENT OF WOUNDS CONTAMINATED WITH RADIOACTIVE SUBSTANCES: CONSIDERATIONS ON SIX REPORTED CASES. Ducousso, Roger; Nenot, Jean-Claude; Pasquier, Christian; Lafuma, Jacques (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1972. 37p. (In French). Dep. NTIS (U. S. Sales Only).

This report is intended to assist surgeons concerned with the removal of radioactive substances from wounds. Basic data are presented in the first part: concept of transferability, units used for internal contamination, properties of ^{239}Pu, and the characteristics of x-ray detectors used. The second part deals with six recently published cases and critically reviews the situation in order to reveal the procedure that should be adopted in such cases, and even more important, the procedure that should not be adopted. The third part provides a summary on the surgical handling of a wound contaminated with Pu. (France)

59132 DETERMINATION OF THE ACTIVITY OF ^{90}Sr IN HUMAN BONE. Mendonca, Anamelia Habib; Penna Franca, Eduardo (Univ. Federal, Rio de Janeiro). An. Acad. Brasil. Cienc.; 43: No. 3-4, 813-20(1971). (In Portuguese).

Several studies have been published in the literature on the extent and levels of radioactive contamination of food chains caused by fallout from nuclear weapon tests. According to UNSCEAR, these studies cover a great number of areas of the developed world, though large areas of Asia, Africa, and South America are left aside with only unsatisfactory information about the levels of radioactive contamination. In 1968, UNSCEAR recommended that a survey on the contamination of biological materials such as human bone be encouraged in those areas where only fragmentary information was available. UNSCEAR recommendations call upon the fact that presently a great number of individuals have been exposed to ^{90}Sr contamination from birth to their adult age. Therefore, that group should have a ^{90}Sr skeletal burden very much different from people exposed only at adult age. Based on these considerations, UNSCEAR recommendations called for ^{90}Sr analysis on human bones from different age groups. In Brazil, studies on the concentration of ^{90}Sr in human bone are practically non-existent, except for the year of 1959. Following UNSCEAR recommendations it was decided to perform such a survey on ^{90}Sr levels in human bones. Samples were collected from individuals that died in Rio de Janeiro from accidents. These samples were first classed according to social level in very poor and poor groups. Samples were then separated into three age groups ranging 0 to 18, 18 to 30, and 30 to 40 years of age. Results showed that levels found in the Brazilian age groups are close to the ones observed in Chile (1969), Argentina and Australia (1966–1968) and slightly higher than those observed in Venezuela, Senegal, and Jamaica (1969). If one compares the results obtained for the North and South hemispheres respectively, it is evident that there was a more pronounced decrease in the levels of ^{90}Sr in bones from populations of the North hemisphere, which seems to indicate that recent atmospheric tests undertaken by French in the Pacific, contributed in a slight way to increase the ^{90}Sr content of the diet of some regions of South America. The results showed no significant difference between mean values of the three age groups studied. However when one considers only five samples, from 18 months to 9 years old, the average is significantly higher than the ones of older ages. These results seem to indicate that a more thorough study should be performed where levels of ^{90}Sr in human bones and in the constituents of the Brazilian diet could be related. (auth)

59133 AMERICIUM CONTAMINATION INCIDENT. Whalen, Robert P. (Bureau of Radiological Health, Albany); Davies, Sherwood. N. Y. State J. Med.; 72: No. 19, 2430-4(1 Oct 1972).

An incident of ^{241}Am contamination is reported by the New York State Department of Health. It involved the removal of an ^{241}Am source from a laboratory to the home of one of the personnel. The investigative procedures, monitoring methods, and subsequent decontamination techniques are discussed. Monitoring of the family, using whole-body counting, is continuing. All promises involved have been decontaminated, and contaminated objects packaged for ground burial. (E.R.B.)

59134 ^{228}Th CONTENT IN TOBACCO AND THE HUMAN BODY. Petushkov, A. A.; Zel'tser, M. R.; Medvedovskii, A. P. (Inst. of Hygiene and Occupational Disease, Moscow). Gig. Sanit.; No. 4, 113-14(Apr 1972). (In Russian).

In addition to radioisotopes previously reported in tobacco products, the presence of ^{228}Th (halflife 1.9 yrs) was discovered from a measurement of ^{220}Th emanation present. The combined activity of radiothorium and polonium found in five different tobacco preparations is reported. The ash from one cigarette contained 0.09 pCi. A discussion relates to the probable content in the smoke that was retained by the body of the smoker. Using a special scintillation counter, the Th content in two groups of persons was measured: for smokers, 0.28 ± 0.03; and for non-smokers, 0.14 ± 0.02 pCi/1. (K.S.W.)

59135 ^{210}Po IN BLOOD AND URINE OF URANIUM MINE WORKERS IN YUGOSLAVIA. Novak, Lj.; Panov, D. (Inst. of Occupational and Radiological Health, Belgrade). Amer. Ind. Hyg. Ass. J.; 33: No. 3, 192-6(Mar 1972).

Two groups of uranium miners were studied to determine the correlation between the concentrations of atmospheric radon to which they were exposed and the concentrations of Polonium-210 in their blood and urine. Radon exposures were of the order of $7.61 \pm 0.25 \times 10^{-10}$ Ci/liter. The excretion of ^{210}Po in urine was 1.03 pCi/liter for miners exposed 3 years, and was 1.63 pC/liter for miners exposed for 10 to 12 years. For one group the concentrations of ^{210}Po correlated with the radon exposures but for the other group the correlation was not statistically significant. (auth)

Animals

Refer also to abstracts 58783 and 58808.

59136 (COO-1787-16) STUDY OF THE TRANSLOCATION OF PLUTONIUM AND AMERICIUM FROM PUNCTURE WOUNDS. Fourth Technical Progress Report, June 16, 1971–June 15, 1972. Lebel, J. L.; Watters, R. L. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). 30 Jun 1972. Contract AT(11-1)-1787. 113p. Dep. NTIS.

The prime objective of this research project is to provide new understandings on the movement of plutonium and americium from wound site to target organs in the body. This objective can be partially achieved by determining if the ratio of reactor-produced plutonium isotopes to the inherent ^{241}Am would be altered during the translocation of the material from contaminated wound sites to major points of deposition in the body. Measurements by in vivo counting, assays of blood and excreta, as well as of necropsy samples obtained from serial sacrifices provides another part of the data needed to understand the translocation kinetics of americium and plutonium from the wound site. Studies of the relative distribution of plutonium to americium, the kinetics of movement relative to time and the effect of DTPA therapy on the translocation dynamics are described. The effect of delayed lymphadenectomy on the translocation dynamics of high fired PuO_2 from subcutaneous implants is being extensively studied and preliminary findings are presented. The experimental results reported in this fourth technical report summarize the activities and information gathered between July 1971 and June 1972. Most of the assays involving the dogs contaminated in 1969 with $Pu(NO_3)_4$ have been completed and summarized in this report. All of the dogs included in the PuO_2 (high fired) experiment have been sacrificed and part of the assays have been completed. The plutonium fluoride (PuF_4) experiment is still in progress. To this date, 18 dogs have been injected with the suspension and the results of in vivo counting included. Nine of the ten dogs implanted in 1969 with air oxidized plutonium are still under observation for possible lymphosarcoma induction. In addition, we have injected another group of 8 dogs with a $Pu(NO_3)_4$ solution for the same purpose of studying the long-term effects of a different chemical and physical form of Pu on lymphosarcoma induction. An experiment is underway to investigate the clearance mechanism of plutonium from lymph node and reticulo-endothelial cells. High fired PuO_2 was used for this experiment. The suspension was injected in the left hind paw and at selected time intervals after amputation, the left popliteal and external iliac lymph nodes are being examined for histologic, cytologic, and ultrastructural changes. These subjects are discussed in detail. In the appendix we have included the papers presented by the members of this laboratory at the Eleventh Hanford Biology Symposium: The Biological Implications of the Transuranium Elements. The symposium was held on September 26 to 29, 1971, Richland, Washington. (auth)

59137 EFFECT OF AMINOALKYLPHOSPHONIC ACIDS ON THE ELIMINATION OF URANIUM FROM THE ORGANISM. Balabukha, V. S.; Ivannikov, A. T.; Razbitnaya, L. M. Gig. Tr. Prof. Zabol.; No. 9, 29-32(Sep 1972). (In Russian).

Data on the study of complex-forming properties of aminoalkylphosphonic acids with respect to uranyl and their effectiveness in eliminating uranium from the body of rats are presented. Seven different aminoalkylphosphonic acids were studied. All of them fix uranium quite well and accelerate its elimination from the organism. As regards their efficacy they are superior to aminocarboxylic acids. Uranyl complexes with aminoalkylphosphonic acids are shown to be characterized by a considerable strength and a comparatively low solubility. Some features peculiar to their effect depending upon the number of functional groups and the presence of the hetero-atom N, S, and O in the carbon ring were revealed. Aminoalkylphosphonic acids hold out promise in accelerating elimination of uranium. (auth)

59138 BIOGEOCHEMISTRY OF THORIUM ISOTOPES IN THE OCEAN. Patin, S. A.; Tkachenko, V. N. (All-Union Marine Fisheries and Oceanographical Scientific Research Inst., Moscow). Geokhimiya; No. 8, 1006-11(Aug 1972). (In Russian).

By using methods of gamma-spectrometry and measuring beta-activity, the disequilibrium concentration of thorium-234 was determined in antarctic phytoplankton and zooplankton (krill). The accumulation of thorium-234 by krill was found to be mainly due to their filtration activity. The biological uptake of thorium-234 from water and the biosedimentation migration of this nuclide in separate regions of the ocean may influence the space distribution of thorium-234 in water masses during a time less than the mean life-time of thorium-234. The results suggest the geochemical importance and perspectivity of studies of the individual radioecological situations of natural radioisotope accumulation by marine hydrobionts. (auth)

59139 SOME REGULARITIES OF ^{90}Sr ACCUMULATION IN THE BODY OF A RAT IN A HIGH FLUORINE CONTENT IN DRINKING WATER. Danetskaya, E. V.; Knizhnikov, V. A.; Ramzaev, P. V.; Troitskaya, M. N. Gig. Sanit.; No. 8, 49-53 (Aug 1972). (In Russian).

A preliminary introduction (for a period of 1.5 months) of fluorine in water produced a certain fall in the ^{90}Sr concentration in the ashes of rats' bones and corpses although the total content of the isotope in the body remained unaltered. (auth)

59140 URANIUM ACCUMULATION IN KIDNEYS AND BONE TISSUE FOLLOWING CHRONIC INGESTION. Novikov, Yu. V. (Moscow Scientific-Research Inst. of Hygiene). Gig. Sanit.; No. 6, 109-10(Jun 1972). (In Russian).

The accumulation of U in the kidneys and skeletal tissue of white rats was studied following the chronic administering of uranyl nitrate by mouth. The tissue analyses indicated that uptake of U by kidneys and skeleton was related to the concentration in the solution administered. (K.S.W.)

59141 ACCUMULATION OF ^{89}Sr IN INTACT SKIN OF SUCKLING PIGS AFTER CONTAMINATION WITH STRONTIUM NITRATE SOLUTION. Norets, T. A.; Il'in, L. A.; Shamov, V. P.; Shvydko, N. S. (Leningrad Scientific-Research Inst. of Radiation Hygiene). Gig. Sanit.; No. 6, 106-9(Jun 1972). (In Russian).

A solution of $^{89}Sr(NO_3)_2$ was applied to the skin of 4-week old pigs (32 cm^2 at a concentration of 10 $\mu Ci/cm^2$). The pigs were sacrificed and the surface layers of flesh were divided with a microtome. Significant amounts of ^{89}Sr could be detected within 15 min after the application of the radioactive preparation, and at all levels below the skin from 0 to 2,000 μ. This subcutaneous contamination persisted up to 24 hr (the end of the test period). (K.S.W.)

59142 RATE OF EARLY La UPTAKE BY ALVEOLAR MACROPHAGES. Ducousso, Roger (Centre de Recherches du Service de Sante des Armees, Paris); Masse, Rolland. Compt. Rend., Ser. D; 274: No. 24, 3328-31(12 Jun 1972). (In French).

The separation of the cellular fraction of the short term rat lung washing liquid enabled the rate of disappearance of chelatable lanthanum by phagocytosis to be determined. The results are compared with those obtained from therapeutic experiments with DTPA on contaminated respiratory tracts. (France)

59143 DTPA-TREATMENT OF WOUND CONTAMINATION BY RADIOACTIVITY. AN EXPERIMENTAL MODEL. Boemer, H. (Kernforschungszentrum, Karlsruhe, Ger.). Strahlentherapie; 143: No. 6, 664-9(Jun 1972). (In German).

Rats were injected intramuscularly with ^{88}Y and ^{144}Ce, respectively. Different doses of DTPA (15 to 120 $\mu mol \cdot kg^{-1}$) were administered intravenously after 15 min, either rapidly or as a three-hr infusion. The retention of both radionuclides by liver and skeleton is lowered by DTPA and there is a distinct dependency on dosage. Dependent on the kind of the radionuclide as well as of the tissue, the rapid injection proved either more or less effective than slow infusion. DTPA enhances the absorption of ^{88}Y from the injection site. No effect was observed with ^{144}Ce. The practical implications of these findings are discussed. (auth)

59144 BIOLOGICAL EXPERIMENTS WITH TRANSURANIUM ELEMENTS. Volf, V.; Polig, E.; Seidel, A. KFK Nachr.; 4: No. 2, 20-3(1972). (In German).

From bones of animals exposed to transuranium elements, 20 to 30 micron thick sections were cut. X-ray pictures of the sections were then evaluated for α-activity by automatic microscopic examination and analysis. To facilitate elimination of the incorporated transuranium elements, the animals were treated with Ca-DTPA and Zn-DTPA. In general, the two chelates are equally effective; early after incorporation, however, Ca-DTPA was superior. It is concluded that Zn-DTPA may have a place in long-term therapy of transuranium element incorporation. (H.B.G.)

59145 URANIUM IN ANIMALS FROM THE ADRIATIC SEA. Risik, N. S. (Inst. of Biology of the Southern Seas, Sevastopol, USSR. Vestn. Zool.; 4: No. 2, 12-15(1970). (In Russian).

Coefficients of U accumulation and its radioactivity were studied in some animals in the Adriatic Sea. The concentration factors can be of various magnitude from units and tens in Mytilus galloprovincialis to hundreds in Arbacia sp. In the body of Verongia aerophora the U microcongeries were higher by 2 to 3 orders than the average contents in other organisms. (Euratom)

Plants

59146 (UCLA-34-P-51-35) BEHAVIOR OF CERTAIN SYNTHETIC CHELATING AGENTS IN BIOLOGICAL SOIL SYSTEMS. Annual Progress Report for the Fiscal Year. Wallace, Arthur (California Univ., Riverside). 15 May 1972. Contract AT(04-3)-34. 99p. Dep. NTIS.

Nitrilotriacetate at 5000 kg/ha was slightly toxic to bush beans (Phaseolus vulgaris) grown in Yolo loam soil and at rates of 500 to 1000 kg/ha increased contents of Fe, Zn, Mn, Cu, Mo, Pb, Co, Al, and Ni in leaves. Most of these were also increased in stems. Iron-59 was used in studies on iron absorption from different sources from soil by two different soybean varieties. Studies were conducted on the effects of soil pH and the chelating agent DTPA on the uptake and distribution of ^{241}Am and ^{114m}In in bush bean plants. (H.L.W.)

59147 FOLIAR RETENTION, TRANSPORT, AND LEACHING OF ^{210}Po AND ^{210}Pb. Athalye, V. V.; Mistry, K. B. (Bhabha Atomic Research Centre, Bombay). Radiat. Bot.; 12: No. 4, 287-90(Sep 1972).

Polonium-210 and ^{210}Pb, the long-lived daughter radionuclides of gaseous ^{222}Rn, are deposited on plant surfaces under conditions of atmospheric washout. Foliar retention, transport and leaching of these radionuclides in Phaseolus vulgaris L. (red kidney beans) were investigated in nutrient culture experiments. Under identical conditions, over 90% of foliar applied radiolead was retained by the plant while only about 30% of polonium was retained. Over a 48 hr period small quantities of polonium were translocated from the treated leaflet to other parts of the plant. By comparison, radiolead was totally immobilized at the site of retention. Leachability of root absorbed radiolead from bean leaves was 20-fold greater than that of Po. The marked differences in the extent of foliar retention, translocation and leaching of Po and radiolead could significantly affect the levels of these long-lived radionuclides attained in plants. (UK)

59148 ^{210}Pb AND ^{210}Po IN BULGARIAN TOBACCO. Nikolova, M. E. Gig. Sanit.; No. 6, 81-3(Jun 1972). (In Russian).

The material selected for this study of ^{210}Pb and ^{210}Po in Bulgarian tobaccos came from the 1968 harvest of 36 regions of the six leading Bulgarian tobacco-producing areas. A total of 150 assays of ^{210}Pb and over 170 assays of ^{210}Po were conducted. The content of these two isotopes was different in tobacco leaves from different areas; the composition of soil and variety of tobacco affected the results. The ^{210}Pb content ranged from 0.225 to 0.682 pCi/g; the ^{210}Po content from 0.209 to 0.583 pCi/g. These data are compared with similar data from the USSR and the USA. (K.S.W.)

59149 MANGANESE, BARIUM, AND NATURAL RADIOACTIVITY OF FOOD PRODUCTS IN GOITER AND NON-GOITER DISTRICTS OF KIEV. Mikhalyuk, I. A.; Motuzkov, I. N.; Yatsula, G. S. (Kiev Medical Inst.). Vrach. Delo; No. 10, 135-7(1970). (In Russian).

The Mn and radioactivity content in the food from goiter and nongoiter regions was almost the same. The Ba content was much higher in the endemic goiter regions. In the fruit products from the control region the Ba content was 2.04 ± 0.26 to 206 ± 21.1 mg/100 g fresh wt. while in the endemic goiter region it was 1.24 ± 0.13 to 566.0 ± 47.8 mg/100 g fresh wt. (auth) (EURATOM)

New Tracer Techniques

59150 COMMON RADIOACTIVE CARRIER FOR DIFFERENT SPECIFIC ANTIGENS: APPLICATIONS TO RADIOIMMUNOLOGY. Dubois, Maurice P. (Institut National de Recherches Agronomiques, Nouzilly, France); Pelletier, Jean; Drouet, Jacques. Compt. Rend., Ser. D; 274: No. 20, 2822-5(15 May 1972). (In French).

The use of a protein carrier coupled to each antigen is proposed as a simplified system to replace ^{125}I and ^{131}I labeling of the antigens in radioimmunology. This method enabled the titration curves of β-(1-24) corticotropine, prolactine, and LH ovine to be obtained, each of these hormones being coupled with ^{125}I labeled human albumin. (France)

59151 STUDY OF RENAL BLOOD FLOW IN THE NON-ANESTHETIZED RABBIT USING ^{85}Kr. Gruenfeld, J. P.; Bankir, L.; Funck-Brentano, J. L. (Hopital Necker, Paris). Rev. Eur. Etud. Clin. Biol.; 17: No. 4, 399-405(Apr 1972). (In French).

The disappearance of ^{85}Kr from the renal artery was used to estimate the total renal blood flow and the cortical fraction in nonanesthetized rabbits. A technique for chronically catheterizing the renal artery is described. The disappearance curve for the ^{85}Kr is externally recorded. Hemodynamic measurements were repeated during a 1 to 9 hr interval. Anatomic and functional controls demonstrated a perfect tolerance with respect to prolonged catheterization. The mean renal blood flow is 3.9 ± 0.1 ml/g min; 73.3 ± 1.7% of the Kr is initially distributed in the renal cortex; the cortical blood flow is 5.9 ± 0.2 ml/g min. (France)

59152 EVALUATION OF THE MEASUREMENT OF THE RENAL BLOOD FLOW BY THE ^{133}Xe WASHOUT TECHNIQUE IN DOGS. Kahn, R. J.; Gottignies, P.; Vanherweghem, J. L.; Lambert, P. P. Rev. Eur. Etud. Clin. Biol.; 17: No. 4, 389-94(Apr 1972).

A satisfactory correlation exists between the mean flows obtained from the ^{133}Xe washout curves and the venous renal flows measured simultaneously in dogs. Too rapid injection of the tracer into the renal artery can significantly decrease the venous blood flow during the ensuing minute. The correlation between the mean flows calculated from the washout data and the venous flows is more satisfactory when the venous flows measured during the first post-injection minute are used in the comparison rather than the pre-injection values. A mean 5.2% decrease in the venous outflow was observed during the first minute after intra-arterial injection of the tracer although only 0.8 ml per sec was injected. The ^{133}Xe elution curve recorded by external counting during 20 min was able to be divided into three exponential portions for all the experiments performed ($n = 38$). When the recording time was extended to 45 min, on four occasions the curve was able to be divided into four exponential components ($n = 15$). A mathematical analysis of the multiexponential curves did not improve the correlation between the flows obtained from the elution curve and the venous flows in comparison with graphical analysis. (France)

59153 THEORETICAL ESTIMATION OF THE ERROR INVOLVED IN DETERMINING THE BLOOD VOLUME USING A SINGLE TRACER. Morin, P. P.; Lahellec, M.; Morin, J. F.; Caroff, J.; Savina, A. (Centre Hospitalier Regional Augustin-Morvan, Brest, France). J. Biol. Med. Nucl.; 7: No. 28, 21-6 (1972). (In French).

An inherent error occurs when a single tracer is used to measure blood volumes. The exact magnitude of this error can only be estimated using a double tracer method. A single tracer technique was developed in which the risk of the error could be estimated. Some experimental verification of this method is presented. (France)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 58671, 58928, 58949, 59219, 59220, 59240, 59242, 59295–59297, 59328, 60433, 60439, 60449, 60455, 60458, 60459, 60560–60564, 60569, and 60571–60576.

59154 (JUL–846-RW) INVESTIGATIONS TO DECREASE THE RELEASE OF SOLID FISSION PRODUCTS FROM COATED FUEL PARTICLES BY THE ADDITION OF REFRACTORY OXIDES TO THE FUEL KERNEL. Foerthmann, R.; Hamesch, M.; Nickel, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). May 1972. 37p. (In German). Dep. NTIS (U. S. Sales Only).

For increasing the retention of solid fission products in coated fuel particles, investigations were made on oxide fuel kernels containing Al_2O_3. It was the purpose of this work to test the possibility of retaining solid fission products in the kernel by formation of stable ternary oxides. Using the hydrolysis process, UO_2 and $(U,Th)O_2$ kernels were prepared which contain the solid fission products Sr, Ba, Ce in concentrations corresponding to a burnup of about 10% fima. After an out-of-pile heat treatment of these kernels, the fission product release was measured. The Sr release at 1250°C was found to be smaller if the kernels contain Al_2O_3 in amounts of 1 to 5 weight percent. The solid fission products were enriched in the inclusions of Al_2O_3 which is not soluble in the UO_2 matrix of the kernel. (auth)

59155 (KFK–1621) RECOVERY PROCESSES IN OXIDE LATTICE OF QUENCHED AND NEUTRON-IRRADIATED URANIUM DIOXIDE. Vollath, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Jun 1972. 35p. (In German). Dep. NTIS (U. S. Sales Only).

Recovery processes occurring in quenched and neutron-irradiated uranium dioxide in the temperature region between room-temperature and 500°C are due to the migration of defects in the oxygen sublattice. Migration of uranium defects was not observed. Oxygen Frenkel defects are annealed at temperatures of about 400°C. The recovery step is found to be independent of specimen stoichiometry for irradiated and quenched samples. Recovery processes which were found in the temperature region between 150 and 250°C are characteristic for hyperstoichiometric material. (auth)

59156 (ORNL-tr–2634) ULTRASONIC STUDIES OF THE STRUCTURE OF ISOTROPIC PYROCARBON COATINGS ON COATED PARTICLES. Suetterlin, L.; Buesch, H.; Luhleich, H.; Nickel, H.; Hoven, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Translated for Oak Ridge National Lab., Tenn., from report JUL–798-RW. 41p. Dep. NTIS.

Studies were made on the behavior of coated particles under high energy loading using ultrasonic equipment. With this method it was aimed to get a further characteristic for the description of HDI layers. The first part deals with the theoretical methods in order to describe the setup. It gives an estimate of the ultrasonic quantities and describes the effect of the ultrasonic on the coatings i.e. the HDI layer, of nuclear fuel particles. The second part describes the experiments that were performed with an ultrasonic equipment of constant frequency and power. Different types of particles were irradiated by the ultrasonic apparatus within a methanol bath. This device leads to a dispersion of small pieces dispersed from the coating into the methanol bath. The concentration of these dispersed particles has been measured as a function of the ultrasonic energy, by means of optical extinction. Parallel to the above mentioned measurements some of the particles to be investigated, which have not been irradiated, were analyzed for its structure of the HDI layer with the help of the so-called ''Kaltoxydation'' of microsections. For the interpretation of the measured extinction curves the kaltoxydated microsections were used. From the results it was concluded that different patterns of HDI layers reveal different extinctions. Between the optical extinction and the structure of the HDI layer exists a qualitative correlation. A very distinctive shell structure of the HDI layer revealed a rather low extinction. (P.C.H.)

59157 (ORO–3955-3) CRYSTAL STRUCTURE AND MORPHOLOGY OF HYDROUS OXIDES AND HYDROXIDES IN THE LANTHANIDE AND ACTINIDE SERIES. Final Report, June 1, 1969–May 31, 1972. Milligan, W. O. (Baylor Univ., Waco, Tex.). 1972. Contract AT(40-1)-3955. 241p. Dep. NTIS.

X-ray and electron diffraction studies and electron microscopy were carried out on hydrous lanthanide systems to give a better understanding of their aging and crystallization behavior. Freshly precipitated gels of hydrous lanthanides were found to be composed of amorphous-like, finely-divided particles approximately 10 Å in diameter. Aging of the amorphous precipitates under water at room temperature or at 100°C and in teflon bomb tubes at 160°C yield crystalline products accompanied by various changes in morphology generally to rod- or scroll-like particles. Lighter members of the series yield hexagonal, $P6_3/m$, crystals isomorphous with the UCl_3 prototype, whereas the heavier members of the series first yield a variety of poorly crystalline or crystalline products distinct from $P6_3/m$, but more extended aging especially in strong sodium hydroxide solution at elevated temperatures yields the standard hexagonal structure, the transformation becoming more difficult as the atomic number is increased. In contrast to earlier investigators, a plot of the lattice constants vs. atomic number of crystal radii yield smooth curves. Accurate lattice constants have been determined for the hydroxides of La, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, and Y. A new crystalline phase for the $Ln_2O_3-H_2O$ system was found for an isomeric series of hydrous lanthanides and a preliminary refinement of the $Nd(OH)_3$ structure by the powder method was made. Infrared data for the lanthanide trihydroxides are also presented. (auth)

59158 (Y–1831) PREPARATION OF ALUMINUM TITANATE CRUCIBLES BY SLIP CASTING FOR HIGH-TEMPERATURE APPLICATIONS. Morrow, M. K.; Holcombe, C. E.; Cromer, C. A. (Oak Ridge Y-12 Plant, Tenn. (USA)). 29 Sep 1972. Contract W-7405-eng-26. 19p. Dep. NTIS.

An alumina–titania mixture $(Al_2O_3-TiO_2)$ was synthesized by the hydrolysis of a refluxed benzene solution of the respective metal isopropylates. This powder, after calcining, was mixed with a 0.5% solution of sodium alginate in a 43 gm/57 ml ratio to form a suspension suitable for slip casting. Several thick-walled crucibles were cast and later sintered to produce aluminum titanate (Al_2TiO_5) crucibles as the end product. This material is of special interest because of its applicability for containing molten uranium without contaminating the metal. (auth)

59159 LOCALIZED OR UNIFORM HYDRIDING OF ZIRCALOY: SOME OBSERVATIONS ON THE EFFECT OF SURFACE CONDITIONS. Lunde, L. (Institutt for Atomenergi, Kjeller, Norway). J. Nucl. Mater.; 44: No. 2, 241-5(Aug 1972).

Closed tubes of Zircaloy-2, 300 mm long with a diameter of 13 mm and a wall thickness of 0.8 mm, were exposed at 400°C for 1 to 48 h with an internal hydrogen pressure of 2 to 4 atm. The tubes had sandblasted or pickled inside surfaces and were tested as received, with local fluoride contaminations, as autoclaved, and autoclaved with scratches. It was found that a sandblasted surface tended to absorb hydrogen uniformly and rapidly. In this case the surface acts as a hydrogen getter. This suggests that sandblasting should be a preferred surface treatment. Similarly, treatments that prevent corrosion reactions and uniform hydrogen absorption should be avoided. With such treatments reactive species are retained longer. (P.C.H.)

59160 STRUCTURAL INVESTIGATIONS OF THE UPPER LAYERS FORMED ON CEMENTED CARBIDES AS THE RESULT OF PHOTON EROSION. Gibas, T. (Inst. of Metal Cutting, Krakow). Microtecnic (Lausanne); 26: No. 4, 226-9(May 1972).

The results of ceramographic investigations presented show that the percussive character of the heat phenomena accompanying photon beam drilling, not to be noticed in any other technological process, influences also the structure of even such high-melting material as cemented tungsten carbide. It has been found that evaporation and condensation processes and resulting from them, transfer of the machined material, may prevent all the products from being carried away from the hole, but it may only be partly translocated and form very hard outer layers. The inner zone consisting of undisplaced material shows traces of melting, recrystallization, and impoverishment in lower-melting metallic components. Subsequently, that leads to lessening of the hardness of the outer layers and it may cause loss of cohesion and continuity of the base material. More study, particularly diffraction analysis within microareas, may supply further information especially as to the diffusion phenomena in conditions of photon erosion. Apart from the process itself, sintered carbide structures that are formed during the process deserve attention, and among other uses, from the point of view of practical use. (auth)

59161 VARIATION OF INTERIONIC DISTANCES IN OXIDES BETWEEN 298^0 AND 1773^0K. Min'ko, N. I.; Fabrikant, S. A.; Plationov, Yu. K. Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 2, 184-6(Feb 1972).

Translated from Zh. Fiz. Khim.; 46: No. 2, 312-15(Feb 1972).

Temperature coefficients of interionic distances and their variation were calculated for several oxides at temperatures from 298.15 to 1773°K. A formula is suggested for determining the temperature variation of interionic distances in compounds that undergo transitions. (auth)

59162 INFLUENCE OF PRECIPITATION CONDITIONS ON THE PROPERTIES OF AMMONIUM DIURANATE AND URANIUM DIOXIDE POWDERS. Janov, J.; Alfredson, P. G.; Vilkaitis, V. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Nucl. Mater.; 44: No. 2, 161-74 (Aug 1972).

Continuous precipitation in one and two stages was investigated to determine the effects of precipitation variables on the properties of ADU precipitates and the sinterability of subsequent UO_2 powders in pellet fabrication. The pH at which precipitation occurred was the most important parameter in determining the size of ADU agglomerates and the settling rate and filterability of the slurry. In two-stage precipitation, the ADU properties were determined by the proportion of uranium precipitated at different pH values. Washing nitrate from ADU appeared not to affect the properties of the subsequent UO_2 powder but a significant decrease in filterability occurred when the ADU was extensively washed. When ADU was reduced to UO_2 at 600°C the agglomerate structure of the ADU was retained. The larger the agglomerates in the UO_2 powder (lower pH of precipitation of precursor ADU) the less sinterable it was; pseudomorphs of large agglomerates were still discernible in the sintered pellets. Thus settling rate of the ADU slurry gave an early indication of the likely sinterability of the resultant UO_2 powder since both were functions of agglomerate size. (auth)

59163 OBSERVATIONS RELATING TO THE MECHANISMS OF SWELLING AND GAS RELEASE IN URANIUM DIOXIDE AT HIGH TEMPERATURES. Chubb, W.; Storhok, V. W.; Keller, D. L. (Battelle Columbus Labs., Ohio). Contract W-7405-eng-92. J. Nucl. Mater.; 44: No. 2, 136-52(Aug 1972).

Thirty-six specimens of UO_2 and UO_2-PuO_2 clad in tungsten–rhenium were irradiated at surface temperatures from 1260 to 1900°C. Six specimens were equipped with gas pressure monitors; two were made of fully dense oxide; one was constructed with a tungsten barrier foil at mid-radius; and one had an outer annular region of depleted uranium oxide. The gas release behavior, density and dimensional changes, and microstructural characteristics of these specimens were analyzed. It was deduced that the sequence of events occurring in oxide fuels at high temperatures is sintering and grain growth, gas bubble growth, overlap of gas bubbles growing on grain boundaries, gas release through grain boundary networks, migration by vapor transport of large lenticular voids formed on circumferentially oriented grain boundaries to produce radially oriented columnar grains (this constitutes "restructuring"), and continual formation, growth, and migration of bubbles inside grains to produce steady-state swelling, gas release, and fission-product removal in the high-temperature regions of oxide fuels. (auth)

59164 NUCLEAR BACKSCATTERING ANALYSIS OF Nb–Nb_2O_5–Bi STRUCTURE. Ziegler, J. F.; Berkenblit, M.; Light, T. B.; Park, K. C.; Reisman, A. (IBM Watson Research Center, Yorktown Heights, N. Y.). IBM J. Res. Develop.; 16: No. 5, 530-5(Sep 1972).

The technique of nuclear backscattering was used to analyze the interface reactions of $Nb-Nb_2O_5-Bi$ multilayer films. This new analytical technique is explained in detail. It was concluded that the drastic and erratic changes in the electrical properties of niobium oxide switchable resistor devices that take place at 450°C are associated with the gross migration of oxygen from the oxide to the niobium layer. The accompanying reactions of bismuth with the oxide are relatively moderate, diffusing less than 3×10^{11} atoms/cm^2 of bismuth into the oxide layer. (auth)

59165 MULTIPLET LINES IN THE MASS SPECTRA OF NIOBIUM AND ITS OXIDES. Palatnik, L. S.; Obol'yaninova, O. A.; Naboka, M. N. (Kharkov Polytechnic Inst.). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 3, 372-5(Mar 1972).

Translated from Zavod. Lab.; 38: No. 3, 299-302(Mar 1972).

Multiplets observed in the spectra of Nb, Nb oxides, and impurities found in these materials were investigated. Multiplets of Nb and the Nb compounds are presented for mass numbers M = 93, and M = 109, and M = 125. (J.R.D.)

59166 REVEALING THE STRUCTURAL COMPONENTS OF HARD ALLOYS (EXCHANGE OF EXPERIENCE). Baranova, L. V.; Buzovskii, Yu. N. (All-Union Scientific-Research Tech. Inst. for Chemical, Pump and Compressor, and Reinforcing Machine Construction, Sumi, USSR). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 2, 268(Feb 1972).

Translated from Zavod. Lab.; 38: No. 2, 213-14(Feb 1972).

A method is described for determining the structure of WC–Co alloys. The structure is revealed by etching polished samples using a saturated solution of ferric chloride in hydrochloric acid at 18 to 20°C for 10 to 15 minutes. The sample is washed in alcohol and dried in hot air. (J.R.D.)

59167 METHOD OF INVESTIGATING THE WEAR OF HARD TUNGSTEN CARBIDE–COBALT ALLOYS IN A LIQUID NITROGEN MEDIUM. Shnyrev, P. D.; Drobinin, I. N. (Moscow Inst. of Chemical Engineering). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 2, 302-4(Feb 1972).

Translated from Zavod. Lab.; 38: No. 2, 239-41(Feb 1972).

The relations of wear and the physical and mechanical properties of these hard alloys and the relations of wear and operating parameters of the frictional test pairs at liquid nitrogen temperatures were investigated. Results of the investigation were used as the basis for establishing laws of wear rate change. Possible uses of these alloys in cryogenic technology are discussed. (J.R.D.)

59168 REACTION OF ZIRCONIUM VAPOR WITH GRAPHITE. Gert, L. M.; Babad-Zakhryapin, A. A. Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 2, 332-3(Feb 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 2, 381-2(Feb 1972).

To determine the possibility of the appearance of the complex phase when the vapor of a transition metal is condensed on a hot graphite substrate, Zr was selected as the condensing metal. Zr vapor was reacted with the graphite substrate at 1700 (±30°C). The phase composition of the layers was determined by x-ray analysis, which revealed that their lattice constants varied within the limits $4.701 \geq a \geq 4.690$ Å and $4.685 \geq a \geq 4.630$ Å. The lattice constant of the first phase coincided with the known value for zirconium carbide. On the other hand, the lattice constant of the second phase decreased regularly with increasing residual pressure. Experiments with inleakage of air indicated an absence of regions of transitional composition between the two phases. (P.C.H.)

59169 MEASUREMENT OF THE HEAT OF FORMATION OF INTERMETALLIC COMPOUNDS BY THE SINTERING METHOD IN AN ISOTHERMAL CALORIMETER. Gorelkin, O. S.; Dubrovin, A. S.; Kolesnikova, O. D.; Chirkov, N. A. (Chelyabinsk Metallurgical Research Inst., USSR). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 3, 431-2(Mar 1972).

Translated from Zh. Fiz. Khim.; 46: No. 3, 754-5(Mar 1972).

A method of measuring the heat of formation of silicides and other intermetallic compounds in a large-capacity calorimeter by utilizing the heat of combustion of metallothermic charges to effect sintering of the powdered, mixed components. The heats of formation ΔH°_{298} (kcal mole^{-1}) of a number of silicides and borides were determined: -18 ± 2 (FeSi), -112 ± 13 (V_5Si_3), -36 ± 6 (VSi_2), -122 ± 22 (Nb_5Si_3), -17 ± 3 (FeB), -16 ± 5 (Fe_2B), -24 ± 3 (NiB), -74.5 ± 9 (Ni_4B_3). (auth)

59170 PRIMARY CRYSTALLIZATION REGIONS IN THE SYSTEM Y_2O_3–Fe_2O_3–50PbO.40PbF_2.10B_2O_3. Sapozhnikov, Yu. L.; Titova, A. G. Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 2, 288-90(Feb 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 2, 330-2(Feb 1972).

The primary crystallization fields were investigated in the pseudoternary system $Y_2O_3-Fe_2O_3-50\ PbO \cdot 40\ PbF_2 \cdot 10\ B_2O_3$. The regions of predominant crystallization of garnet, orthoferrite, and yttrium oxyfluoride were distinguished. The optical compositions for garnet crystallization contained 20 to 35 mole% of crystal-forming components, with the ratio of Y_2O_3 to Fe_2O_3 in the range 1.3 to 1.5; the optimal compositions for orthoferrite crystallization contained 20 to 25 mole% of these components, the ratio of Y_2O_3 to Fe_2O_3 being 1 : 1. (auth)

59171 STATISTICAL DISTRIBUTION OF OPEN POROSITY IN UO_2 SINTERED BODIES. Amato, I.; Catti, M. (FIAT, Turin). Phys. Sintering; 4: No. 2, 87-95(May 1972).

The open pore distribution of UO_2 sintered bodies with different densities was examined using the mercury porosimetry. The porosimetric curves were interpreted as cumulative distribution functions of pores. Statistical parameters were calculated for every distribution function, and their dependence on the densities of sintered bodies shown. As a result of investigation, it was observed that during the first stage of sintering the pore distribution is independent of density, and during the final stage the same distribution shifts towards larger sizes. (auth)

59172 GLASS FORMATION REGION AND SOME GLASS PROPERTIES IN THE SYSTEM TeO_2–V_2O_5–Fe_2O_3. Marinov, M. R.; Kozhouharov, V. S. (Inst. of Chemical Technology, Sofia). Compt. Rend. Acad. Bulg. Sci.; 25: No. 4, 499-502(1972).

The results of studies on the glass-formation region, as well as the crystallization capacity and density of glass in the system $TeO_2-V_2O_5-Fe_2O_3$ are reported. The results showed that the oxides of V and especially of Te acted like glass-formers, while an increase in the Fe_2O_3 content above 35 mole% led to the complete crystallization of the melts. The glass-formation limits found in the particular binary systems were: for $TeO_2-Fe_2O_3$ from 97.70 to 77.57 mole% TeO_2; for $V_2O_5-Fe_2O_3$ from 92.50 to 83.25 mole% V_2O_5; and for $TeO_2-V_2O_5$ from 42.00 to 92.50 mole% TeO_2. The glass density varied within a range from 3.50 to 5.40 g/cm^3 and increased with an increase in the TeO_2 content. (P.C.H.)

59173 NITRIDING OF Sr. Motte, Jean Pierre.; Brice, Jean Francois; Aubry, Jacques. (Univ., Nancy). Compt. Rend., Ser. C; 274: No. 22, 1814-16(29 May 1972). (In French).

The presence of hydrogen in metallic Sr leads to the production of two nonstoichiometric phases ($Sr_3N_{2-x}Hy$ and one other) when the metal is nitrided. It also prevents the total nitriding of the metal and the formation of the corresponding ionic nitride, Sr_3N_2. (France)

59174 SPECTROSCOPIC INVESTIGATION OF OXIDE INTERACTION WITH METAL SURFACE. II. THE SYSTEMS SiO_2–Fe(Cu, Al, Ni, Co, Ti, W). Karpinos, D. M.; Listovinichaya, S. P.; Aivazov, V. Ya. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 71-5(Jun 1972). (In Russian).

By means of infrared spectroscopy, the interaction of silica with different metal surfaces was investigated before and after annealing within the temperature range of 600 to 1500°C in vacuum. An appearance of additional bands was observed in infrared absorption spectra. They characterized the interaction of silica with a metal backing, which might be evoked by polarizing effect of the latter. Changes in the spectra are discussed, depending on the backing material and thermal treatment of the samples. (auth)

59175 DEPENDENCE OF PROPERTIES OF GROUP IV–V TRANSITION METAL MONOCARBIDES ON CARBON CONTENT. Vinitskii, I. M. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 76-82(Jul 1972). (In Russian).

Within the terms of a single model based on the conception of the covalent bond Me–C predominance in monocarbides, consideration was given to the properties in which the homogeneity region is different for carbides of metal of the Groups IV and V. The developed concepts were in agreement with the experimental investigation of a direct change in the electronic structure within the homogeneity regions of monocarbides. The monocarbides studied included TiC, ZrC, HfC, VC, NbC, and TaC. (auth)

59176 THERMAL EXPANSION COEFFICIENT OF CURIUM-248 DIOXIDE, $^{248}CmO_2$. Noe, M. (Univ., Liege); Peterson, J. R. Inorg. Nucl. Chem. Lett.; 8: No. 10, 897-902(Oct 1972).

In the measurements reported, use was made of the recently available long-lived isotope of mass number 248, in order to circumvent the effects of intense self-irradiation on properties, such as may occur with ^{244}Cm. Details are given of the method of preparation of the $^{248}CmO_2$. The thermal expansion of the fcc lattice parameter was studied at increasing and decreasing temperatures. The observed expansion behavior with increasing heating was reversed identically on cooling, indicating complete reversibility of the thermal expansion process. Results are tabulated. The lattice parameters varied linearly with temperature up to 360°C, but at higher temperatures the parameter was larger than expected by linear extrapolation, indicating that thermal decomposition of the dioxide was taking place with formation of some Cm(III). The mean value in the temperature range 20 to 360°C was calculated as $(10.16 \pm 0.55) \times 10^{-6}/°C$. This value is ~20% greater than the value reported for $^{244}CmO_2$. (UK)

59177 ENTHALPY OF $UO_{2\ 25}$ TO 1600 K BY DROP CALORIMETRY. Macleod, A. C. (Univ. of Strathclyde, Glasgow). J. Chem. Thermodyn.; 4: No. 5, 699-708(Sep 1972).

The enthalpy of $UO_{2.25}$ was measured in the temperature range 800 to 1600°K by means of an adiabatic vacuum drop calorimeter. All temperatures are based on IPTS-48. A transition with an associated enthalpy increment of (560 ± 25) cal$_{th}$ mole^{-1} occurred in the temperature region 1395 to 1405°K. The results are correlated with existing heat capacities and are represented below the transition temperature by the equation: $H^0(T) - H^0(298.15°K) = \{16.82(T/K) + 2.654 \times 10^{-3}(T/K)^2 + 70252(T/K)^{-1} - 5487\}cal_{th}\ mole^{-1}$, and above the transition temperature by the equation: $H^0(T) - H^0(298.15°K) = \{17.85(T/K) + 2.507 \times 10^{-3}(T/K)^2 + 153743(T/K)^{-1} - 5989\}cal_{th}\ mole^{-1}$. The correlation with low-temperature heat capacities suggests a value for $C_p^0(298.15°K)$ of 17.00 cal$_{th}$ K^{-1} mole^{-1} which would result in a value of 19.938 cal$_{th}$ K^{-1} mole^{-1} for the entropy at 298.15°K, and 145 cal$_{th}$ K^{-1} mole^{-1} for the entropy increment of the λ-type transition in the temperature region 260 to 360°K. The thermodynamic properties of $UO_{2.25}$ have been calculated from 300 to 2000°K. (auth)

59178 INVESTIGATION OF HOT PRESSING KINETICS IN ALLOYS MADE OF TITANIUM AND TUNGSTEN CARBIDES CEMENTED WITH NIOBIUM. Koval'chenko, M. S.; Bogomol, I. V.; Serebryakova, T. I. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 15-21(Jun 1972). (In Russian).

Kinetics of sintering cermets TiC–Nb and WC–Nb with a metal component content of 25, 50, and 75 at.% by means of hot pressing was investigated. It was established that compaction during cermet sintering is controlled by the processes of transient creep at the initial stage of hot-pressing and that of steady-state creep at the subsequent stage. (auth)

59179 LOW DENSITY PYROLYTIC CARBON COATING PROCESS. Beutler, Hans; Beatty, Ronald L. (to Union Carbide Corp.). U. S. Patent 3,682,759. 8 Aug 1972. Filed 10 Mar 1970.

A process for depositing a low-density, highly porous carbon coating on nuclear reactor fuel particles by the thermal decomposition of undiluted exothermic-type cracking gases is described. The temperature control of the coating process is obtained by alternately using, as the particle fluidizing medium, the exothermic-type cracking gas and an inert gas to maintain the temperature of the reaction zone between about 1100 and 1250°C. (Official Gazette)

59180 METHOD FOR THE PREPARATION OF URANIUM OXIDE SOLS. Hurley, Forrest R.; Tecotzky, Melvin; Vanik, Milton C. (to W. R. Grace and Co.). U. S. Patent 3,691,087. 12 Sep 1972. Filed 20 Feb 1968.

A process for preparing sols of urania composed of particles in the 60 to 1900 angstrom size range which comprises electrodialyzing a solution of a tetravalent salt of uranium in a multicompartment cell wherein the compartments are separated by an ion exchange resin membrane is described. (Official Gazette)

59181 SYNTHESIS OF SINGLE-CRYSTAL CARBIDES AND SULFIDES OF URANIUM AND THORIUM. Adachi, Hirohiko; Henmi, Yukio; Imoto, Shosuke. Technol. Rep. Osaka Univ.; 22: 121-5(Feb 1972).

Single crystals of UC, US, ThC, and ThS were prepared by electron beam melting of the material, which were synthesized by direct reaction between elements followed by degradation of higher compounds if necessary, and subsequently by annealing of the ingots at about 1900°C for several hours in vacuum. The Laue method in x-ray diffraction revealed that the cleavage surface of these crystals lies on {100} plane. (auth)

59182 NEUTRON-DIFFRACTION STUDY OF YTTRIUM TRIHYDRIDE. Miron, N. F.; Shcherbak, V. I.; Bykov, V. N.; Levdik, V. A. Sov. Phys.-Cryst. (Engl. Transl.); 17: No. 2, 342-4(1972).

Translated from Kristallografiya; 17: No. 2, 404-6(1972).

A neutron structural analysis was made of hexagonal YH_3 to determine the positions of the D atoms in the hexagonal Y matrix. The x-ray reflection pattern was indexed with a hcp lattice with $a_0 = 3.66$ and $c_0 = 6.60$ Å. Best agreement between experimental and calculated intensities was obtained for a model with space groups $P\bar{3}c1$. The structure of $YD_{\bar{3}}$ is derived from an ideal structure with 12 tetrahedral and 6 octahedral D atoms with small displacements. Interatomic distances and coordinations are tabulated; they show that YD_3 is isostructural with H_0D_3. (D.L.C.)

59183 FUEL FABRICATION. Thomas, Ivor (Kerr-McGee Corp., Oklahoma City). pp 125-35 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

The fabrication of nuclear reactor fuel elements for use in the commercial production of electric power is discussed. For the fabrication of fuels consideration must be given to the environment it must withstand, design parameters that must be considered in order to achieve the desired performance, fuel-cycle cost economics, and plant capacity effects. A typical manufacturing process for the production of water reactor fuels is given. It was concluded that there is some overcapacity in the UO_2 fuel fabrication industry and serious overcapacity in the mixed oxide fuel industry through 1974, rapid growth in capacity beyond 1975 will be a necessity. (P.C.H.)

59184 FABRICATION OF NUCLEAR FUEL ASSEMBLIES AND RESULTANT PRODUCT. Boyko, Eugene S.; Campbell, Joseph. U. S. Patent 3,683,148. 8 Aug 1972. Filed 5 May 1970.

A nuclear fuel assembly is described which has an end plug and is sealed except for a small diameter axial bore in the plug. The plug provides a collar around the outer end of the bore which when fused provides sufficient material to seal the bore. Before the bore is sealed the assembly is filled with an inert-gas at high pressure. An electric arc is then established between an electrode and the collar to melt the collar sufficiently to seal the bore. (Official Gazette)

59185 CAVITATION EROSION OF COBALT BONDED TUNGSTEN CARBIDE CERMETS. Tichler, J. W.; de Gee, A. W. J. Lubric. Eng.; 27: No. 12, 428-32(Dec 1971).

The cavitation erosion resistance in water of Co-bonded WC cermets was studied as a function of carbide grain size and Co percentage. Also, the effects of intermediate exposure to humid air were studied. It was found that, under conditions of uniform material removal, cermets with 6% Co had a higher resistance against erosion than cermets with 30% Co. On the contrary, with respect to the resistance against pitting, a high Co percentage was favorable, in particular if applied in combination with a small carbide grain size. Probably pit formation was accelerated by a process of atmospheric corrosion along the grain boundaries. (Metals Abstr.)

59186 DIFFUSION DATA. VOLUME 6, NUMBER 2-3, 1972. Woehlbier, F. H. (ed.). Diffus. Data; 6: No. 2-3, 351-548(1972).

Data are given on diffusion in solid metals and alloys, liquid metals and alloys, semiconductors, oxides, halides and other ionic substances, carbides, silicides, and organic crystals. A bibliography with over 200 references is included along with author, host substance, and phenomenological topic indexes. (P.C.H.)

59187 MARTENSITIC PHASE TRANSFORMATION IN ZIRCONIA (ZrO_2). I. METALLOGRAPHIC EVIDENCE. Bansal, G. K.; Heuer, A. H. (Case Western Reserve Univ., Cleveland). Acta Met.; 20: No. 11, 1281-9(Nov 1972).

The tetragonal–monoclinic phase transformation in ZrO_2 single crystals and polycrystals was studied in both the forward and reverse directions and found to be martensitic. A large hysteresis is involved in the transformation, the A_s and M_s temperature being ~1050 and ~950°C, respectively; surface relief accompanies the transformation in both directions. A high-temperature metallographic study established the athermal and shear-type nature of the transformation and was consistent with a diffusion-less reaction. Two different habit planes were found and their orientations have been determined by two-surface optical analysis as ~(106) and ~(010) (referred to the monoclinic phase). Fully transformed single crystals and polycrystals have been studied by transmission electron microscopy and the microstructural features resulting from the phase transformation analyzed. In addition to confirming the two habit planes, the electron microscopy indicated that the lattice invariant shear usually occurs by slip rather than by twinning. Deformation twins have been observed in all the electron microscope foils, however, and are believed to arise from accommodation stresses generated during the transformation. (auth)

59188 IMPROVEMENTS IN THE INCORPORATION OF IRIDIUM IN URANIUM DIOXIDE. Ainscough, John Brian; Oldfield, Brian Wilfred (to United Kingdom Atomic Energy Authority). British Patent 1,283,608. 2 Aug 1972. Filed 28 May 1969.

Fission gas release from UO_2, consequent on diffusion or grain growth, can be inhibited by addition of high-melting refractory metals, and the use of Ir in this connection, within the range 0.1 to 4% by weight, is covered by BP 1,137,551. In order to be of maximum effectiveness the Ir addition must be finely divided and uniformly dispersed within the UO_2, and a process is described for effecting this, starting with a HNO_3 solution of uranyl nitrate, to which is added an Ir compound that decomposes to give Ir metal on heating. Ammonia is added to the solution to precipitate ammonium diuranate mixed with the finely divided Ir compound, and the precipitate is calcined and reduced to convert the Ir compound to metal and the diuranate to UO_2. The preferred Ir compound is IrO_2 or Ir hydroxide. (UK)

59189 VYSOKOTEMPERATURNAYA KHIMIYA SILIKATOV I OKISLOV. (High-Temperature Chemistry of Silicates and Oxides). Third All-Union Conference, Leningrad, November 28–29, 1968. Keler, E. K. (ed.). Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1972). 212p. (CONF-681144).

This collection of 53 papers on the chemistry of silicates and oxides at high temperatures is grouped into the following four sections: thermodynamics and crystal chemistry, the physical chemistry of refractory oxide systems, the physico-technical properties of complex oxides, and new substances and materials based on pure oxides. Approximately 15 of the 53 papers are of nuclear interest, since they are concerned with the rare earth oxides, and the compounds or systems: Sc_2O_3, $Sc_2O_3-ZrO_2$, ZrO_2 and ZrO_2 with HfO_2 and with rare earth oxides, CeO_2, ThO_2, V_2O_5 with BeO or other oxides, $Pr_2O_3-Nb_2O_5$, and Nd_2O_3-SrO. (K.S.W.)

59190 MECHANISM OF THE REACTION OF Ln_2O_3 AND $Zr(Hf)O_2$. Krzhizhanovskaya, V. A.; Shcherbakova, L. G.; Keler, E. K.; Glushkova, V. B. (Inst. of Silicate Chemistry, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 3, 466-8(Mar 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 3, 536-9(Mar 1972).

Reactions of oxides in the systems $Ln_2O_3-Zr(Hf)O_2$ at high temperatures were investigated using x-ray microprobe analysis. It was found that rare earth oxides diffuse in ZrO_2 and HfO_2. The sequence of phase formation during reactions of oxides in the systems $Ln_2O_3-Zr(Hf)O_2$ was established. (auth)

59191 OXIDATION OF SOLID SOLUTIONS OF VANADIUM, SCANDIUM, AND CHROMIUM SESQUIOXIDES IN AIR. Zhilyaev, V. A.; Perelyaev, V. A.; Shveikin, G. P. (Inst. of Chemistry, Sverdlovsk, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 3, 503-4(Mar 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 3, 576-7(Mar 1972).

The oxidation characteristics of these solid solutions were investigated using a derivatograph. Experimental results are tabulated and discussed. (J.R.D.)

59192 REDISTRIBUTION OF Nd_2O_3 BETWEEN STABILIZED ZrO_2 AND Al_2O_3. Strakhov, V. I.; Klyucharov, Ya. V.; Sergeev, G. G. (Leningrad Technological Inst.). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 3, 505-6(Mar 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 3, 578-9(Mar 1972).

The feasibility of producing new ZrO_2–base structural materials was studied. The composition $Nd_2Zr_2O_7 : Al_2O_3$ was studied. It was found that phase transformations take place during roasting of this composition involving formation of $Nd_2O_3 \cdot Al_2O_3$ and solid solution $Nd_2O_3 \cdot ZrO_2$. The solid solution $Nd_2O_3 \cdot ZrO_2$ is very stable. (J.R.D.)

59193 INVESTIGATION OF ISOTHERMIC SECTIONS OF THE SYSTEM $ThO_2-Y_2O_3-WO_3$. Pokrovskii, A. N. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 3, 302-5(1972). (In Russian).

Two isothermal sections of the $ThO_2-Y_2O_3-WO_3$ system at 1000 and 1200°C were studied. (auth)

59194 SOME STUDIES OF REACTOR FUEL MATERIAL USING A MATERIALS TESTING REACTOR. Findlay, J. R. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inst. Nucl. Eng.; 13: No. 5, 131-6(Sep 1972).

A limited selection of experimental work that has been undertaken using the DIDO and PLUTO MTR reactors at Harwell is described, with emphasis on the chemical aspects of fuel behavior, and in particular fission product behavior, which influences many of the design aspects of fuel elements and reactor systems. In these reactors thermal neutron fluxes between 6×10^{12} and 2.4×10^{14}n/cm²/sec and fission fluxes between 7×10^{8} and 1.7×10^{14}n/cm²/sec can be selected, depending on position, and heat ratings between 1 × 1000 W/g, in terms of irradiation of oxide fuel, can be achieved by suitable combinations of flux and possible enrichment, this range embracing all systems of current interest to the UK nuclear program, including the fast reactor. Fast flux unmoderated experimental positions are provided in the center of annular fuel elements. (UK)

59195 TERNARY SYSTEM W–Ni–B. Kiparisov, S. S.; Nikiforov, O. A.; Kuz'mina, Yu. K. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 2, 88-91 (1972). (In Russian).

Twelve alloys whose compositions lay within the W–Ni–B ternary diagram were prepared and investigated. The microhardnesses of four alloys were measured from each of the three cross sections: W_2B-Ni, $WB-Ni$, and W_2B_5-Ni, and powder diffraction patterns were obtained. (K.S.W.)

59196 COLLECTIVE RECRYSTALLIZATION IN ZIRCONIUM CARBIDE. Samsonov, G. V.; Bozhko, S. A. (Kiev Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 2, 96-100 (1972). (In Russian).

The recrystallization processes in Zr carbide samples having various amounts of vacancies in the carbon sublattice were studied. The compositions of the samples ranged from $ZrC_{0.62}$ to $ZrC_{0.98}$, and the isothermal growth of grains were noted during ½ to 4 h annealing periods at temperatures from 1,750 to 2,000°C. Collective recrystallization began at 1,750 to 1,800°C, the activation energy of this process decreasing with increased quantity of carbon vacancies in the carbide lattice. (K.S.W.)

59197 REACTIONS OF NIOBIUM PENTOXIDE WITH GALLIUM AND INDIUM SESQUIOXIDES. Plotkin, S. S.; Plyushchev, V. E. (Inst. of Fine Chemical Tech., Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 2, 279-82(Feb 1972).

Translanted from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 2, 319-24(Feb 1972).

The character of reactions in a mixture of coprecipitated hydroxides and the phase composition of the systems $M_2O_3-Nb_2O_5$ (M = Ga, In) were investigated using thermal and x-ray phase analysis and measurements of the electric conductivity. Dehydration of gallium hydroxide led to formation at 230°C of the monohydrate $Ga_2O_3 \cdot H_2O$ with a diaspore structure, and was completed at 445°C. Crystallization of β-Ga_2O_3 began at 700°C. No thermal effects due to formation of other modifications of Ga_2O_3 were recorded. Dehydration of $In_2O_3 \cdot nH_2O$ took place continuously at 200 to 320°C. Anhydrous In_2O_3 crystallized at 520°C. The results of x-ray phase analysis confirmed that the system $Ga_2O_3-Nb_2O_5$ contained two compounds with molar ratio $Ga_2O_3 : Nb_2O_5 = 1:1$ and $1:5$. Phases with other compositions were not observed in the system. The system $In_2O_3-Nb_2O_5$ contained one compound with a 1:1 molar ratio of the oxides. The compounds synthesized had high thermal and chemical stabilities. They were not decomposed by solutions of alkalies and acids (except Hf) and were inert with respect to organic solvents. Prolonged heating at 1300°C caused a weight loss of not more than 0.5%. (P.C.H.)

59198 IMPROVEMENTS IN NEUTRON ABSORBERS. **Shepherd, Leslie Robert; Hosegood, Samuel Brittan (to United Kingdom Atomic Energy Authority). British Patent 1,283,159. 26 Jul 1972. Filed 21 May 1970.**

A thermal neutron absorber comprising a solid ceramic body incorporating silicon nitride is described for use in a high-temperature nuclear reactor. The absorber may be enclosed in a N_2 atmosphere within a gas-tight container. The function is to provide a "grey" control member. The ceramic body may be composed of a nitride or carbide of B, and reinforcing filaments of a refractory metal, such as Mo or W, may be incorporated. The absorber may be used as a control rod or for thermal neutron shielding. Details are included for preparation of the absorber material. (UK)

59199 APPLICATIONS OF POWDER METALLURGY IN THE NUCLEAR INDUSTRY. Accary, A. Powder Met.; Conf. Suppl. 1, 1-7(1971).

Attempts were made to use powder-metallurgy methods for the preparation or manufacture of some of the many materials needed in the nuclear industry. Several cases are cited: the production of uranium metallic fuel; the application of metal/oxide composites (e.g., Al/Al_2O_3 and Mg/MgO) as structural materials; the production of uranium carbide and mixed uranium–plutonium carbide fuels; the production of uranium oxide and mixed uranium–plutonium oxide fuels. The reasons for the success or failure of these attempts are analyzed and tentative conclusions are drawn regarding the conditions under which powder metallurgy is likely to prove a successful tool in this field. (auth)

59200 PRODUCTION OF SULPHUR-MODIFIED URANIUM CARBIDES. **Korogiannakis, P.; Wedemeyer, H. (Kernforschungszentrum, Karlsruhe, Ger.). Ber. Deut. Keram. Ges.; 49: No. 8, 249-52(Aug 1972). (In German).**

Because sulfur-containing nuclear fuels of the carbide type perhaps have better compatibility, production of uranium carbosulfide with 1 to 4% of uranium monosulfide was investigated. A method of preparing uranium oxysulfide from a reaction between uranium dioxide and carbon disulfide is described and the activation enthalpy of the reaction was found to be q = 74.2 ± 0.5 kcal/mole. A carbothermal reduction of uranium oxysulfide is possible within the range of 1350 to 1400°C. Above the latter temperature a gradual breakdown of uranium oxysulfide into uranium dioxide and uranium disulfide begins. In metallurgical practice, uranium carbosulfides can be easily produced by melting pure components in an electric arc under argon. A method that is technically more favorable would be a carbothermal reduction of partially reduced uranium oxysulfide together with uranium dioxide; after reduction times of 5 h at 1380°C and 3 h at 1850°C a uranium carbosulfide with oxygen impurities of c 1000 ppM can be obtained. (auth)

59201 SOME COMPOUNDS IN THE SYSTEM $PbO-P_2O_5$, $PbO-As_2O_5$, AND $PbO-V_2O_5$. **Hodenberg, R. v. (Technische Hochschule, Hanover). Ber. Deut. Keram. Ges.; 49: No. 8, 243-8 (Aug 1972). (In German).**

The compounds $8\ PbO \cdot P_2O_5$, $8\ PbO \cdot As_2O_5$, $8\ PbO \cdot V_2O_5$, $4\ PbO \cdot P_2O_5$, and $4\ PbO \cdot V_2O_5$ were synthesized and their crystallographic data determined. The most interesting observation was the intergrowth of $8\ PbO \cdot V_2O_5$ with $4\ PbO \cdot V_2O_5$. (auth)

59202 PREDICTING THE PRODUCTION AND USE OF REFRACTORIES. **Strelov, K. K. Refractories (USSR) (Engl. Transl.); 13: No. 1-2, 65-8(1972).**

Translated from Ogneupory; 13: No. 2, 1-4(Feb 1972).

The predictions are based on development of pyroprocesses likely in the years 1980 to 1985. The most significant raw materials are predicted to be SiO_2, CaO, MgO, ZrO_2, Cr_2O_3, Al_2O_3, SiC, and C for producing refractories. Research efforts required for development of such refractories are outlined. (J.R.D.)

59203 SPALLING RESISTANT ALUMINA–ZIRCON REFRACTORY. Kainarskii, I. S.; Orlova, I. G.; Natsenko, I. A. (Ukrainian Scientific-Research Inst. of Refractories, Kiev). Refractories (USSR) (Engl. Transl.); 13: No. 1-2, 97-102(1972).

Translated from Ogneupory; 13: No. 2, 31-7(Feb 1972).

Development of spalling resistant alumina is reported. Results of experiments are described in which additions of aluminum titanate, fused silica, cordierite, silicon carbide, zircon, anorthite, mullite, unstabilized zirconia, or electrofused corundum were incorporated in aluminum oxide ceramics. The highest thermal shock resistance was found in alumina-zircon ceramics. The production technology associated with alumina–zircon technology is described. (J.R.D.)

59204 SYNTHESIS AND INVESTIGATION OF PROPERTIES OF COMPLEX OXIDES OF RARE EARTHS AND ZIRCONIUM. Portnoi, K. I.; Timofeeva, N. I.; Salibekov, S. E.; Romanovich, I. V. Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 2, 358-60 (Feb 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Materl; 8: No. 2, 406-8(Feb 1972).

The complex oxides of Zr and rare earths of the composition $R_2O_3 \cdot 2ZrO_2$ were obtained for the whole series of rare earths, with the exception of Ce and Pm, and their physicochemical properties were investigated. The zirconates were formed at different rates, which increased from La to Lu. Studies on physicochemical properties showed that the density of the powders increased from 5.89 (La) to 7.5 g/cm^3 (Lu), x and the melting point increased from 2160°C (La) to 2600°C (Yb). The synthesized compositions were very stable when heated in solutions of concentrated or dilute acids (HCl, HNO_3, CH_3COOH, $HClO_4$, and HF), and in solutions of ammonia or caustic soda; they were relatively soluble in hot concentrated H_2SO_4. The oxides hardly reacted at all with water, which was indicated by the absence of rare earths in the water after treatment with boiling water for 10 h and by retention of the initial crystal structure. X-ray structural analysis of $R_2O_3 \cdot 2ZrO_2$ specimens, kept in a current of hydrogen at 1100°C (5 h), revealed the stability of the crystal structures in a reducing atmosphere for all rare earths, with the exception of Gd, Tb, and Ho, which decomposed into two cubic solid solutions of the fluorite type after residence in hydrogen. (P.C.H.)

59205 REACTION OF A GRAPHITE–ZIRCONIUM CARBIDE COMPOSITION WITH FUSED ALUMINUM. **Shurshakov, A. N.; Krasil'nikov, G. D.; Posos'eva, G. D.; Dergunova, V. S. Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 3, 397-400(Mar 1972).**

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 3, 454-8(Mar 1972).

The corrosion resistance of a composition material (graphite-25 vol.% zirconium carbide) during interaction with fused aluminum in a crucible and during evaporation of aluminum from the surface of a plate was studied. A plate with a cross section of 9 × 18 mm heated to 1500°C retains its efficiency under conditions of vacuum evaporation of aluminum from its surface for 3 to 4 h of continuous operation. The change in the contact angle of wetting during interaction of fused aluminum with graphite–zirconium carbide material at 1000 and 1200°C was also studied. Aluminum spreads less rapidly over this composition material than over pure graphite. (auth)

59206 HYDROGEN DIFFUSION STUDIES USING NUCLEAR MAGNETIC RESONANCE. **Cotts, Robert M. (Cornell Univ., Ithaca, N. Y.). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 760-70(Aug 1972).**

Nuclear magnetic resonance (NMR) techniques have been applied in a considerable number of experimental studies of molecular and atomic motion in solids. In most experiments designed to measure diffusion parameters, the power spectrum of the random variation of local magnetic dipolar fields is determined directly from the data. Data usually consists of measurements of the nuclear spin system longitudinal spin-lattice relaxation time T_1 or the transverse spin–spin relaxation time T_2, or both. From these measurements the frequency of atomic jumps can be calculated. The analysis also yields the value of the activation energy of self-diffusion for the diffusing atom. Two relatively new NMR techniques, the measurement of the spin lattice relaxation time in the rotating frame, $T_{1\rho}$, and the direct measurement of the diffusion coefficient by observation of the spin echo decay in the presence of an applied magnetic field gradient, are beginning to be utilized in solid state diffusion experiments, but have not yet been applied to metal hydrides. The theory of the effect of atomic motion on nuclear magnetic dipolar interactions is reviewed as the mechanism responsible for spin relaxation. The relationships between T_1, T_2, and $T_{1\rho}$ and the time between atomic jumps, τ_c, is discussed. The pulsed-gradient spin echo technique is outlined for direct measurement of the translational diffusion coefficient. NMR experiments utilizing steady-state and pulsed techniques for studying diffusion in metal hydrides are described for several transition metals including Sc, Ti, V, Y, Zr, Nb, and Ta. Experiments in La, Th, and U-hydrogen systems are also reported. Diffusion parameters, including E_a and A in the Arrhenius relation, $\tau_c = (A^{-1})\exp(E_a/RT)$, are reported. (auth)

59207 PHASE TRANSITIONS OF HYDROGEN IN METALS DUE TO ELASTIC INTERACTION. Alefeld, G. (Technische Univ., Munich). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 746-55(Aug 1972).

Hydrogen in metals can be considered as an example for a lattice gas with phase transitions. A phenomenological discussion of the phase diagrams of hydrogen in Pd, Nb, Ta and V is given. It was shown that these phase diagrams show topologically great similiarity to those which hold for the phase transitions gas-liquid-solid of a one component system. The elastic dipole–dipole interaction is discussed. This interaction is considered to be the predominant part of an attractive interaction responsible for the "gas-liquid" transition. Three experimental methods to measure the mean interaction energy of lattice gas are discussed. Experimental results for the mean interaction energy are compared with theoretical predictions. Arguments are presented that the critical temperature for the gas-liquid transition should be strongly decreased by embedding the sample into material with elastic coefficients stiffer than those of the sample. (auth)

59208 STRUCTURE OF HYDRIDES. Somenkov, V. A. (Inst. of Atomic Energy, Moscow). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 733-40(Aug 1972).

The role of interaction between interstitial atoms in the formation of ordered solid solutions and interstitial compound structures was examined with particular emphasis on the transition metal hydrides. (auth)

59209 STRUCTURAL PROBLEMS OF TRANSITION METAL HYDRIDES. Stalinski, B. (Inst. for Low Temperature and Structure Research, Wroclaw). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 724-32(Aug 1972).

The crystal structure and structurally sensitive properties of transition metal hydrides are reviewed with particular emphasis on the vanadium group and rare earth hydrides. The existing ideas concerning the chemical bond in these substances, and the interpretation of the experimental data recently obtained are presented in some detail. (auth)

59210 THERMODYNAMICS OF METAL/HYDROGEN SYSTEMS. Flanagan, Ted B. (Univ. of Vermont, Burlington); Oates, W. A. Ber. Bunsenges. Phys. Chem.; 76: No. 8, 706-14(Aug 1972).

The thermodynamics of metal/hydrogen systems are reviewed. Emphasis is placed on the thermodynamic properties of hydrogen dissolved in single solid phase regions. Methods of investigation are discussed. A brief survey of recent results on binary metal alloy/hydrogen systems is presented. (auth)

59211 STUDY OF THE REDUCTION OF PLUTONIUM MONONITRIDE BY CARBON FOR MEASUREMENTS OF THE NITROGEN PRESSURE. de Franco, Michel; Marcon, J. P. (CEN, Fontenay-aux-Roses, France). Rev. Chim. Miner.; 9: No. 2, 437-48(1972). (In French).

The high temperature Pu–C–N ternary diagram was investigated from observations of the nitrogen pressure resulting from the reduction of PuN by carbon. The following phases were observed; Pu(C,N) + C(bivariant); Pu(C,N) + PuC_2 + C(monovariant) Pu(C,N) + PuC_2(bivariant); Pu(C,N) + PuC_2 + Pu_2C_3(monovariant). The free energy of formation of PuC_2, Pu_2C_3, and PuN was subsequently derived. The formation of PuC_2 is very sensitive to the presence of nitrogen in solution. The following relations are proposed for PuN and PuC_3: $\Delta GPu_{1.5} = -24700 - 1.92T$(cal/mole); and $\Delta GPuN = -71150 + 20.00T$(cal/mole). (France)

59212 METALLOGRAPHIC AND X-RAY CHARACTERIZATION OF SAMARIUM CARBIDES. Boerner, Gudrun; Goergenyi, Tibor; Venet, Pierre (NUKEM GmbH, Wolfgang, Ger.). Prakt. Metallog.; 9: No. 8, 431-40(Aug 1972). (In German and English).

The chemical, x-ray and metallographic properties of three samarium carbide types are discussed. A special technique was developed for both the x-ray photography and the preparation of polished specimens. The strong tendency to hydrolysis necessitated special specimen preparation. (auth)

59213 PECULIARITIES IN STATE OF TITANIUM AND VANADIUM MONONITRIDE PARTICLES AFTER NITRIDING AND THERMAL TREATMENT. Khaenko, B. V.; Kachkovskaya, E. T.; Orenkel, O. A. (Inst. of Problems in Material Studies, Kiev.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 7, 34-9(Jul 1972). (In Russian).

Phase composition and lattice period were studied in titanium and vanadium mononitride preparations obtained by direct nitriding. It is found that at the initial state the preparations are not equilibrium as a result of formation in the nitriding process of the nitrogen concentrations gradient by the section of a separate grain up to the ultimate composition in surface layers. The equilibrium state of the samples is shown to be achieved by homogenizing annealing for some hours at 1200 to 1400°C in the medium eliminating their further nitriding. The boundaries of titanium and vanadium mononitride existence at temperatures up to 1400°C are specified in the equilibrium examples. (auth)

59214 GROWTH RATE OF PARTICLES OF REFRACTORY OXIDES IN CERAMIC NICKEL. Buntushkin, V. P.; Potemkin, a. I. (All-Union Scientific-Research Inst. of Aviation Materials, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR; No. 7, 82-6 (Jul 1972). (In Russian).

The results of a comparative analysis of the growth of Al_2O_3, Y_2O_3, and HfO_2 particles and their stability in nickel-base alloys with different densities are presented. Effects of microstructural defects on the behavior of dispersed particles in nickel at temperatures above 800°C were established by direct methods of investigation of the alloy microstructure before and after high-temperature annealing and by determining their hot hardness. It is noted that during a short-time annealing (up to 5 h) the growth rate of the oxide particles in nickel with a porosity of 3 to 5% at temperatures of 1100, 1200, 1300, and 1400°C was high and practically did not depend on the nature of the hardening phase. Simultaneously in a dense nickel matrix the ability of the oxide particles to grow in nickel at high temperatures sharply fell, decreasing in the series: $Al_2O_3 \rightarrow Y_2O_3 \rightarrow HfO_2$. (auth)

59215 PHYSICOMECHANICAL PROPERTIES OF FIBROUS CARBIDES. Kats, S. M.; Gorin, A. I.; Semenov, M. V. Porosh. Met., Akad. Nauk Ukr. SSR; No. 7, 87-92(Jul 1972). (In Russian).

The thermal conductivity, strength, normal modulus of elasticity, specific electrical resistance, and short-term creep of a material were measured which was composed of fibrous zirconium carbide 16 to 20 μ in diameter and with a 70 to 90% porosity. The dependence of the five properties listed on temperature and porosity was determined. The results are discussed on the basis of a lattice model of a fibrous material. (tr-auth)

59216 INVESTIGATION OF THE PROCESS FOR OBTAINING NIOBIUM CARBIDE IN FLUIDIZED LAYERS. Gal, V. V.; Nikitin, K. A. (Inst. of High Temperatures, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR; No. 7, 100-3(Jul 1972). (In Russian).

The results are described of investigations on the development of some technological problems of obtaining niobium carbide by graphite through diffusion saturation in a pseudofluidized layer. (auth)

59217 REDUCTION OF THE PHASES OF THE UO_3–V_2O_5–Na_2O SYSTEM BY HYDROGEN. Dion, Christian; Leroy, Jean-Marie; Tridot, Gabriel (Ecole Nationale Superieure, Lille). Compt. Rend., Ser. C; 275: No. 1, 37-40(3 Jul 1972). (In French).

The reduction of the phases of the UO_3–V_2O_5–Na_2O system at temperatures lower than 1000°C by hydrogen gives rise to four new compounds: $NaUVO_{5+x}$ with x lying between 0 and 0.30; $NaUV_3O_{10}$, $Na_3UV_3O_{11}$ and $Na_4UV_4O_{14}$. U(IV)–V(V) is envisaged as a stable oxidoreduction couple for the four compounds studied. These compounds were studied using differential thermal analysis and x-ray crystallography (Debye–Scherrer method). (France)

59218 METHOD OF VIBRATORY LOADING NUCLEAR FUEL ELEMENTS. Sease, John D.; Harrington, Francis E. (to United States Atomic Energy Commission). U. S. Patent 3,683,975. 15 Aug 1972. Filed 12 Feb 1971.

Elongated multi-region LMFBR fuel elements are prepared by preplacing into a container a coarse fraction of material which includes all of the plutonium and a portion of the uranium in the appropriate regions of the fuel element and then infiltrating with vibration simultaneously a fine-sized fraction of depleted uranium-containing microspheres throughout all interstices in the coarse material in a single loading. (Official Gazette)

Metals and Alloys

59219 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. Halbjahresregister 1972. Band 6, Heft 1-6. (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. Semiannual Index. Vol. 6, No. 1-6, 1972. Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H. (1972). 121p. (In German and English).

59220 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. August 1972. Band 6, Heft 8. 130 Referate (Register-Nr.2260-2555); 77 Referate (Register-Nr.550 T-626 T). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. August 1972. Vol. 6, No. 8. 130 Abstracts (Register No. 2260-2555); 77 Abstracts (Register No. 550 T-626 T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H (1972). 108p. (In German and English).

Corrosion and Erosion

Refer also to abstracts 60547, 60560, 60561, and 60563.

59221 (AECL-4057) MATERIAL SELECTION AND CORROSION CONTROL METHODS FOR CANDU NUCLEAR POWER REACTORS. LeSurf, J. E.; Taylor, G. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr 1972. 16p. (CONF-710971-1). Dep. NTIS (U. S. Sales Only).

From Conference of the National Association of Corrosion Engineers; Montreal, Canada (Sep 1971).

The materials of construction and methods of corrosion control of any power station are selected to give the lowest energy cost without jeopardizing safety and reliability. System integrity and minimum deposition on heat transfer surfaces are important objectives in both fossil-fired and nuclear stations. The nuclear station also requires that materials for in-reactor service are reasonably transparent to the reaction-sustaining neutrons, as are zirconium, aluminum and magnesium, corrosion and wear products do not give rise to long-lived radioactive isotopes, as do cobalt and nickel. Water is the heat transport fluid in many power reactors, including all current Canadian ones. In the reactor oxygen is produced by radiolysis, increasing the aggressiveness of the water towards most metals. Suppression of this oxygen production is a primary objective of corrosion control in Canadian reactors. In the pressurized heavy water reactors (CANDU-PHW) suppression is by hydrogen addition; in the boiling light water reactors (CANDU-BLW) ammonia is used. Corrosion of the zirconium alloys used in-reactor is significantly reduced by both the added suppressants. Zirconium alloy corrosion is not markedly affected by the pH of the water but maintaining alkalinity permits use out-reactor of carbon steel which is both inexpensive and low in those elements which can be activated to long-lived isotopes. Lithium hydroxide is used to maintain a pH of 10 to 10.5 in the PHW's while ammonia performs this function in the BLW's. Materials for all components involving penetrations of the circuit (such as valve stems, valve packings and fuel channel end fittings) are selected to ensure very high reliability so as to conserve heavy water. (auth)

59222 (NYO-4117-8) DEVELOPMENT OF HIGH-TEMPERATURE ROLLING BEARINGS FOR OPERATION IN LIQUID SODIUM. Quarterly Progress Report No. 7, January 1-March 31, 1972. Jamison, W. E. (SKF Industries, Inc., King of Prussia, Pa. Research Lab.). 1972. Contract AT(11-1)-3061. 30p. Dep. NTIS.

Operation of the Mark II apparatus for testing rolling bearings in liquid Na at speeds up to 1000 rpm and loads up to 1000 pounds at 1200°F is reported. Tests were conducted during the period on flat washers and ball bearings. Test conditions are described and results are presented graphically and tabularly. (J.R.D.)

59223 (ORNL-TM-3866) CORROSION AND MASS TRANSFER CHARACTERISTICS OF $NaBF_4-NaF$ (92-8 mole %) IN HASTELLOY N. Koger, J. W. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 83p. Dep. NTIS.

A series of corrosion experiments in thermal convection and pump loops designed to test the compatibility of fused $NaBF_4$–8 mole % NaF with Hastelloy N has shown the extreme effect of impurities on the system mass transfer. The difficulty in keeping the melt sufficiently pure was also illustrated. Kinetic considerations showed that the mass transfer process is controlled either by solid-state diffusion or by the solution rate, depending on the amount of impurities allowed to enter the salt. The mass transfer behavior is very similar to that for the $Cr-UF_4$ corrosion reaction (material removal in the hot section and deposition in the cold section), the differences being that alloy constituents other than chromium participate in the process and that the reaction rates are different. Because of these differences, the effective diffusion rate controlling the hot leg attack is larger than that obtained in typical diffusion experiments for chromium in Hastelloy N. Titanium-modified Hastelloy N with less chromium and iron showed a greater resistance to attack in a fluoroborate salt with 500 ppM oxide impurity than does standard Hastelloy N. Its corrosion rate was doubled by increasing the oxide concentration to 1500 ppM. Average corrosion rates were low for all systems tested. (auth)

59224 CALCULATION OF THE RATE OF ATMOSPHERIC CORROSION OF ZINC AND CADMIUM COATINGS IN VARIOUS CLIMATIC REGIONS. Mikhailovskii, Yu. N. Zashch. Metal.; 7: No. 5, 534-9(1971). (In Russian).

The effects of meteorological conditions on the atmospheric corrosion of Zn and Cd coatings are discussed in the light of the latest theoretical and experimental data. The total loss of weight attributable to atmospheric corrosion constitutes the sum of a number of partial losses attributable to different corrosion processes taking place, for example, under layers of adsorbed moisture. By distinguishing between the several processes involved and expressing each in the form of a set of empirical parameters, expressions suitable for determining the corrosion rates under any specified combination of temperature, pressure, and humidity are derived. (Metals Abstr.)

59225 EFFECT OF PHASE COMPOSITION ON THE CORROSION BEHAVIOR OF TITANIUM-15 PERCENT MOLYBDENUM ALLOY IN THE ACTIVE STATE. Tomashov, N. D.; Ruskol, Yu. S.; Ivanov, Yu. M.; Plavnik, G. M. Zashch. Metal.; 7: No. 5, 507-13(1971). (In Russian).

Samples of Ti–15% Mo alloy were given a variety of phase structures by various forms of working and heat treatment (β, $\beta + \omega$, $\beta + \alpha$) and these structures were correlated with the corrosion of the alloy in the active state. The highest corrosion resistance occurred in the case of the simple β alloy, while the two-phase $\beta + \alpha$ material corroded most rapidly. The difference was attributed to the fact that the β contained a higher proportion of Mo than the other phases. A similar situation occurred on alloying Ti with other refractory elements—the best corrosion resistance was always obtained by heat-treating so as to obtain a single-phase product. (Metals Abstr.)

59226 STRESS-CORROSION CRACKING OF HIGH STRENGTH STEELS AND TITANIUM ALLOYS. Judy, R. W. Jr.; Goode, R. J. (Naval Research Lab., Washington, D. C.). Weld. J. (N. Y.); 51: No. 9, 437s-48s(Sep 1972).

One of the major problems of structures in seawater environment is the growth of flaws by the stress-corrosion cracking (SCC) mechanism. Environmental effects on the integrity of the structure are related both to SCC processes and to the inherent tolerance of the material for flaws at regions of high stresses. The ratio analysis diagram (RAD) provides translations of fracture resistance properties of metals to expected structural performance; the RAD has been modified to include analyses of the effects of SCC. The significance of section size effects on the results of SCC tests based on linear elastic analysis methods and expected structural behavior are included on the modified diagram, which is called the Dual-SCC RAD. Examples of several current high strength steels and titanium alloys are referred to the Dual-SCC RAD to illustrate its use. (auth)

59227 STUDY OF THE STABILITY AND PROTECTIVE PROPERTIES OF AN ELECTROLYTIC CADMIUM-TIN ALLOY. Tyutina, K. M.; Kubasova, E. N.; Kudryavtsev, N. T. Zashch. Metal.; 8: No. 1, 78-80(1972). (In Russian).

The corrosion resistance of electrolytic Cd–Sn alloys of various compositions was studied in relation to the use of these materials for protecting steels in seawater and NaCl solutions. As regards corrosion resistance the protective properties of an alloy containing Sn 20 to 40% tested in a humidity chamber differed very little from those of pure Cd; in the presence of a salt cloud the alloy was much better than the pure metal. Increasing the Sn content above 40% however made the protective properties less favorable. (Metals Abstr.)

59228 ELECTROCHEMICAL BEHAVIOR OF CHROMIUM-NICKEL-MOLYBDENUM ALLOYS. Svistunova, T. V.; Kazakova, G. V.; Andrushova, N. V.; Chermenskaya, N. F. Zashch. Metal.; 7: No. 6, 695-8(1971). (In Russian).

The electrochemical behavior of a series of Cr–Ni–Mo alloys (Cr ~15, Mo ~15%) also containing C, Si, Fe, and W in H_2SO_4 was studied in relation to composition and heat treatment. The greatest corrosion resistance in 30% H_2SO_4 at 90°C (independently of the precise form of heat treatment) was exhibited by an alloy containing ~70% Ni with traces of C, Si, and Fe (0.02, 0.06, and 0.8%, respectively. Alloys containing W were less corrosion resistant. (Metals Abstr.)

59229 CORROSION RESISTANCE OF ALLOYS OF THE TITANIUM-TANTALUM-NIOBIUM SYSTEM. Tomashov, N. D.; Chukalovskaya, T. V.; Chernova, G. P.; Budberg, P. B.; Gavze, A. L. Zashch. Metal.; 8: No. 1, 3-7(1972). (In Russian).

The phase transformations and microstructure of Ti–Ta–Nb alloys were studied in relation to the corrosion resistance of these alloys in HCl. The isothermal section at 600°C exhibited a narrow range of α-solid solutions with wide (α/β) and β ranges. The single-phase structures exhibited corrosion resistances several orders of magnitude higher than the two-phase alloys. Alloying Ti with Nb and more especially with Ta materially increased the corrosion resistance of the alloys subject to a limit of 20 to 40% total content of alloying elements. The interchange of Ta and Nb within the total had only a minor effect on the overall corrosion resistance. (Metals Abstr.)

59230 OXIDATION BEHAVIOR OF Ni–Cr–Al–2ThO_2 ALLOYS AT 1093^0 AND 1204^{0}C. Seltzer, M. S. (Battelle Memorial Inst., Columbus, Ohio); Wilcox, B. A.; Stringer, J. Met. Trans.; 3: No. 9, 2391-2401(Sep 1972).

A pack diffusion process was developed which permits the introduction of nearly 6 wt % Al into solid solution in the near surface region of TDNiCr (Ni–20 wt pct Cr–2 vol % ThO_2) and Ni–20 Cr. Alumina scales, adherent under cyclic heating and cooling conditions, were produced on TDNiCr–5.86 Al upon exposure to an environment of $1.33 \times 10^3 N/m^2$ (10 torr) or $1.01 \times 10^5 N/m^2$ (760 torr) air at temperatures of 1093° and 1204°C. While the same oxidation kinetics were observed in isothermal tests for Ni–14.6 Cr–5.86Al as were obtained for the TDNiCr–5.86Al, the dispersion strengthened alloy exhibited superior oxide scale adhesion during cyclic testing. At 1204°C continuous weight gains were observed under all test conditions for TDNiCr–5.86Al, in contrast to the weight loss with time which occurred several hours after exposure of TDNiCr to an oxidizing environment. TDNiCr with an initial aluminum surface concentration of 4.95 wt % had nearly comparable oxidation resistance to the TDNiCr–5.86 Al alloy. Specimens with 4.3 wt % Al at the surface had inadequate aluminum to form Al_2O_3 scales, and weight losses were observed after 40 h upon exposure of these specimens to $1.01 \times 10^5 N/m^2$ (760 torr) air at 1204°C. (auth)

59231 STUDY OF GAS–SOLID CHEMICAL REACTIONS BY A MOLECULAR BEAM TECHNIQUE: NEW INTERPRETATION OF THE REFLECTION OF A HELIUM BEAM ON A RHENIUM SURFACE IN PRESENCE OF OXYGEN. Lintz, Hans-Guenther; Pentenero, Andre (CNRS, Nancy). Surface Sci.; 30: No. 2, 499-503(Apr 1972). (In French).

The degree of covering of the surface of Re by chemisorbed oxygen as determined from measurements of the reflection of a helium beam was recalculated using the Smith and Merrill geometric model. The results showed that the kinetic model proposed by Weber is completely compatible with measurements obtained with the aid of a rare gas beam under the condition that the geometric model, which takes account of the finite radius of the incident atoms, is used. (J.S.R.)

59232 AQUEOUS CORROSION IN NUCLEAR INSTALLATIONS. Coriou, Henri (CEA–CEN, Fontenay-aux-Roses, France). Ind. At. Spatiales; 16: No. 2, 11-34(Mar 1972). (In French).

The corrosion problems posed by the use of austenitic Fe–Cr–Ni alloys in nuclear installations (pressurized or boiling water reactors, plants for the reprocessing of irradiated fuels) were studied. The principal types of stress corrosion occurring are described. The corrosion resistance properties of zirconium alloys used to clad nuclear fuels are also reviewed. (France)

59233 MAGNESIUM ALLOY CLADDING FOR NUCLEAR FUELS. Pugh, S. F. (Atomic Energy Research Establishment, Harwell, Eng.); Antill, J. E.; Mott, B. W.; (and others). J. Brit. Nucl. Energy Soc.; 11: No. 4, 313-30(Oct 1972).

The development and use of magnesium alloy cladding for nuclear fuel elements is reviewed. The composition of alloys for nuclear application is described together with their fabrication, properties, structure and relevant physical properties. Mechanical properties under conditions of temperature and stress relevant to service are reviewed in detail. Critical properties include ductility, creep, high temperature fatigue, and resistance to radiation damage. Corrosion behavior of magnesium alloys in CO_2 and cooling pond water is described and also compatibility with fuel, thermocouple materials, and zirconium alloys which are sometimes used for fuel element components. Development and operational experience of Magnox fuel in UK reactors is reviewed in detail and parallel developments in France are outlined. (auth)

59234 STUDY OF PASSIVATION FILMS FORMED ON STAINLESS STEELS IN MAGNESIUM CHLORIDE SOLUTIONS. Da Cunha Belo, Manuel; Revel, Gilles; Colin, Daniele (CNRS, Vitry-sur-Seine, France). Compt. Rend., Ser. C; 274: No. 23, 1900-2(5 Jun 1972). (In French).

The nature of the films formed on stainless steel exposed to boiling $MgCl_2$(148°C) for 24 h was investigated using electron diffraction techniques. A series of lines, which corresponded to a spinel type oxide, was identified. The quantities of oxygen and chlorine in these passivation films were determined by activation analysis with tritons and neutrons. The relation between the exposure time to $MgCl_2$ and the quantity of oxygen contained in the film was determined. These passivation films play an important role in the fissuration of steels. (France)

Preparation and Fabrication

Refer also to abstracts 59296, 60456, 60562, and 60569.

59235 (EUR–4857) FILLING ALLOYS FOR FAST BREEDER FUEL ELEMENT CONDITIONING. Heylen, P. R.; Wurm, J. G.; Avogadro, A. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Aug 1972. 36p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 50.-.

A filling alloy concept for the conditioning of irradiated fast breeder fuel elements has been studied. The filling alloy is cast into the fuel element at the reactor discharge, so that fuel pins are surrounded by a solid leak tight metal matrix, which improves the mechanical properties of the fuel element and prevents the fission gases from escaping. The following three filling alloys were investigated: Al–Mn (10 wt.%) melting point 700°C, Cu–Mg (9.7 wt.%) melting point 722°C, and Al–V (2 wt.%) melting point 735°C. Laboratory results showed that stainless steel corrosion rates are very low provided the casting temperature does not exceed 800°C. Also Na could be dissolved to some extent. It is shown that with the filling alloy concept most of the unit operations along the head-end flow-sheet will be less complicated and expensive. Transportation of the conditioned fuel elements should be much safer. (auth)

59236 (RDT-M–7-22-T(9-72)) TANTALUM–TUNGSTEN ALLOY BARS AND RODS (AMS 7848 WITH ADDITIONAL REQUIREMENTS). (Division of Reactor Development and Technology (AEC), Washington, D. C.). Sep 1972. 8p. RSO.

A standard prescribing requirements for tantalum–tungsten alloy bars and rods (AMS 7848 with additional requirements) for nuclear and associated applications is presented. (J.R.D.)

59237 (RMI-L–56) PRECISION EXTRUSION OF MARK 30 FUEL CORES. Heiser, R. D.; Cline, J. H. (Reactive Metals, Inc., Ashtabula, Ohio). Jul 1972. Contract AT(30-1)-1405. 15p. Dep. NTIS.

Parameters for extrusion and processing of Mark 30 A, B, C, and D precision cores have been established and all pilot and production runs have been completed. The Mark 30 A precision production run produced a core yield of only 42.6%, even though a number of pilot runs were conducted to determine final sizes. It was concluded that direct extrusion of this geometry is not feasible and that an extrude-die size process would not generate yields competitive with regular production material. Results of the Mark 30 B production run were encouraging and indicated acceptable core yields competitive with standard production materials. It is believed, however, that these results would be difficult to reproduce on a day-to-day basis. In addition, the inability to successfully extrude the other outer sizes would necessitate a double handling system which would erase any cost savings produced by the precision process. The Mark 30 C and D precision geometries proved impossible to be extruded accurately with existing ovality requirements and their addition to the production stream is not recommended. Although the precision extrusion program did not produce results as encouraging as had been hoped, several projects which were initiated in support of the study were successful in improving extrusion conditions and useful information concerning the extrusion process was gained. (P.C.H.)

59238 (SC-M–720458) PROCEDURES FOR ION-PLATING SPR II FUEL. Philbin, Jeffrey S.; Gonzalez, Francisco (Sandia Labs., Albuquerque, N. Mex.). Sep 1972. 35p. Dep. NTIS.

A method used for ion-plating fuel for the SPR II reactor is described. The method provides a means of coating uranium and its alloys with an adherent thin protective coating without the presence of the thin oxide film characteristic of conventional vacuum-depositing techniques. Procedures for operating the vacuum and high-voltage equipment used in the ion-plating process are included. (auth)

59239 (TID–26184) APPLICATION OF CONTROLLED ELECTROMAGNETIC FORCES DURING SOLIDIFICATION OF TYPE 304 STAINLESS STEEL. Eleventh Quarterly Progress Report, January 1–March 31, 1972. Tiller, W. A.; Sherby, O. D. (Stanford Univ., Calif. Dept. of Materials Science). 1972. Contract AT(04-3)-326. 19p. Dep. NTIS.

Efforts during the quarter were directed to stirring experiments and microstructure effects, mechanical property studies of some samples, and a theoretical analysis of some fluid flow characteristics of the stirred melts. (T.F.D.)

59240 MANUFACTURING IN SPACE. Wuenscher, Hans F. (Marshall Space Flight Center, Huntsville, Ala.). Astronaut. Aeronaut.; 10: No. 9, 42-54(Sep 1972).

Processes associated with fabrication of products in low-gravity and zero gravity environments are discussed. The effects of weightlessness on liquid-solid mixtures, supercooling, solidification, crystal formation, chemical reactions, free suspension of materials, and molecular forces are described. A list of potential space products is included along with descriptions of space experiments being conducted. (J.R.D.)

59241 CONTROL OF STAINLESS STEEL WELDING. Safety Guide 31 1972. Washington, D. C.; Directorate of Regulatory Standards, AEC (1972). 9p.

A description is presented of a method for implementing measures to assure materials control and control of special processes for fabrication of nuclear power plant and fuel reprocessing plant components. The emphasis is placed on requirements with regard to the control of welding related to fabrication and joining austenitic stainless steel components and systems. (J.R.D.)

59242 APPARATUS FOR HIGH-SPEED CRYSTALLIZATION OF REFRACTORY METALS (EXCHANGE OF EXPERIENCE). Revyakin, A. V.; Glyuzitskii, B. D.; Samarin, A. M. (Inst. of Metallurgy, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 3, 461-2(Mar 1972).

Translated from Zavod. Lab.; 38: No. 3, 368-9(Mar 1972).

A method is described for regulating the cooling rate of refractory metals. By controlling the cooling rate, it is possible to control metallic grain size and the distribution, shape, and nature of nonmetallic inclusions. The method and equipment was used to obtain foils of Mo and Nb. Micrographs of Nb−2% Al_2O_3 cooled at high rates are included. (J.R.D.)

59243 POTENTIOSTATIC METHOD OF INVESTIGATION IN PHYSICAL METALLURGY (REVIEW). Kolotyrkin, Ya. M.; Nerodenko, L. M.; Yagupol'skaya, L. N. Ind. Lab. (USSR) (Engl. Transl.); 38: No. 3, 357-62(Mar 1972).

Translated from Zavod. Lab.; 38: No. 3, 288-92(Mar 1972).

The application of potentiostatic methods to several processes in physical metallurgy is discussed and reviewed. Information is included on electrolytic polishing, etching of metals and alloys, and dislocation pit etching. (J.R.D.)

59244 BRAZED JOINTS BETWEEN TANTALUM OR NIOBIUM TUBES AND CHROMIUM−NICKEL STEEL. Knauss, Gerhard. Schweissen Schneiden; 23: No. 8, 311-14(Aug 1971). (In German).

Some metallurgical problems concerning the brazing of Ta or Nb to Cr−Ni steel are discussed. Difficulties occur because Cu- and Ag-based solders do not wet Ta or Nb very well and, like Ag solders, other brazing solders, e.g., those based on Ni, Pd, Ti−Zr−Be etc., form brittle alloys. In addition, thermal shock problems occur because of differences in thermal expansion coefficients. Five specific solder compositions are given which in conjunction with a particular joint design permit satisfactory brazing of Nb or Ta tubes to Cr−Ni steel without detriment to the thermal-shock resistance. (Metals Abstr.)

59245 EFFECT OF CONDITIONS FOR OBTAINING METAL TUNGSTEN ON PROPERTIES OF T15K6 ALLOY. Meerson, G. A.; Kreimer, G. S.; Glushkov, V. N.; Panov, V. S. (Inst. of Steel and Alloys, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 31-5(Jun 1972). (In Russian).

The process of WO_3 reduction during one stage was investigated in the industrial muffle furnace with hydrogen supply directly into the furnace. In this case, homogeneous and fine-grained tungsten powder with methanol adsorption more than 0.2 mg/g (specific surface more than 0.76 m^2/g) $d_{aver} < 1$ μ was obtained during one stage without decrease in the furnace productivity. The alloy (Ti−W−base) T15K6 had a finer WC-phase and possessed higher (by 10 to 30%) physicomechanical and cutting properties as compared with the standard alloy T15K6 (Ti−W). (auth)

59246 SOME PECULIARITIES OF PRESSING MOLYBDENIC WIRE (FIBRE). Pochkai, G. N.; Rybal'chenko, M. K.; Samsonov, G. V. Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 10-14(Jun 1972). (In Russian).

The conditions for pressing metallic wires of different diameters, lengths, and states were investigated. Pressed part porosity analytical dependence on pressing pressure was obtained, which was analogous to the dependence of metal powder compaction. Bulk weight of molybdenum wire of different diameters and lengths was determined to grow linearly with the increase of wire diameter and to decrease with increased wire length. (auth)

59247 MECHANICAL PROPERTIES OF TUNGSTEN PRECIPITATED FROM THE VAPOR PHASE. Mal'tsev, M. V.; Ermakov, B. G.; Fastovskii, V. S.; Kuznetsova, V. A. Tsvetn. Metal.; No. 4, 67-9(Apr 1972). (In Russian).

The temperature of transition of tungsten, obtained by hydrogen reduction-precipitation of WF_6 from the gaseous phase, is 600°C, and is on a level with the transition temperature of cast, unalloyed W obtained by electron ray melting. The ductility of the precipitated W is raised as the annealing temperature (in a vacuum at 10^{-5} mm Hg) is increased, and as the corresponding time is increased. The minimum temperature of transition from the malleable to the brittle state was 250°C. Bending experiments showed that the W obtained is plastically deformed under several different regimes of temperature and deformation conditions. Rolling at 1,450 to 1,650°C produced sheets from the precipitated W with a total of 70% deformation. (tr-auth)

59248 PROCESS FOR OBTAINING PREFERRED ORIENTATION IN ZIRCONIUM AND ITS ALLOY. Wiener, George W.; Reynolds, William T.; Aspden, Robert G. U. S. Patent 3,689,324. 5 Sep 1972. Filed 27 Sep 1968.

A process is described in which zirconium and its alloys are subjected to a beta phase heat treatment and during the heat treatment a surface active agent is admitted to the heat treating environment. Thereafter, the metal or alloy is cooled to a temperature below the allotropic transformation temperature. The metal or alloy thus treated is characterized by a preferred orientation which includes a high volume proportion of the grains exhibiting the basal plane (0002) oriented to within 15° of the surface of the material. (Official Gazette)

59249 VERSATILITY OF RESISTANCE WELDING MACHINES FOR JOINING BORON/ALUMINUM COMPOSITES. Hersh, Michael S. (General Dynamics, San Diego, Calif.). Weld. J. (N. Y.); 51: No. 9, 626-32(Sep 1972).

The application of boron filament reinforced, aluminum matrix composites to aircraft and space structures will depend upon the development and optimization of joining techniques. The high modulus and strength of boron/aluminum (B/Al) is the result of the boron reinforcement. The use of mechanical fasteners, which cut into the filaments, therefore results in a significant weight penalty. The joining processes described neither cut nor damage filaments and produce structurally sound joints. Since the fall of 1966 research and development has been continuing in an attempt to produce sound joints between B/Al and B/Al, aluminum alloys and titanium alloys. Commercially available production resistance welding equipment has been used to develop five different joining processes for application with B/Al. The processes (and applicable joints) are: Resistance spot welding (for B/Al−B/Al, B/Al−Al); resistance seam welding (for B/Al−B/Al, B/Al−Al); resistance brazing (for B/Al−B/Al); resistance spot joining (for B/Al−Ti); and resistance spot brazing (for B/Al−Ti). (auth)

59250 ZIRCONIUM ALLOY TUBE WITH ZIRCONIUM HYDRIDE INCLUSIONS. Edstrom, John Olof; Innerman, Sven Eric; Berg, Bengt Henrik; Mills, Brian Edward (to Sandvikens Jernver ks Aktiebolaget). U. S. Patent 3,690,850. 12 Sep 1972. Priority date 1 Feb 1966, Sweden.

A cold-worked tube of zirconium or zirconium alloy is described in which zirconium hydride inclusions formed in the metal are oriented to lie generally parallel to the inner and outer surfaces of the tube, rather than radially of the tube. Cracking and resulting leaking of the tube are negligible. (Official Gazette)

59251 FAIL-SAFE GAS SHIELDING TECHNIQUE DEVELOPED TO WELD ZIRCONIUM REACTOR CORE. Can. Res. Develop.; 5: No. 2, 50(1972).

The 40 MW Taiwan Research Reactor is similar in design to the NRX reactor at Chalk River, Ontario. An innovation is the use of Zircaloy-2 for the entire calandria, chosen for its corrosion resistance and neutron transparency. The welding of zirconium presents problems, and the project required a stringent clean-room fabrication and a pure-argon fail-safe gas shielding system. A mock-up tube sheet was used to provide data on weldment behavior for the geometry and material, and to provide full-scale conditions for testing the techniques and equipment required. (Canada)

59252 ELECTROLYTIC JET THINNING PROCEDURES FOR T.E.M. FOIL PREPARATION OF VARIOUS TECHNICAL ALLOYS. Nelson, James A. (Westinghouse Research Labs., Pittsburgh). Prakt. Metallog.; 9: No. 8, 569-80(Aug 1972). (In German and English).

Starting with an introductory description of the known electrolytic jet thinning procedure for transmission electron microscope foil preparation, the polishing conditions for stainless steels, nickel-, tantalum-, niobium-, tungsten-, titanium-, and zirconium-base alloys are given. The results are documented by T.E.M. micrographs. (auth)

Properties, Structure, and Phase Studies

Refer also to abstracts 58644, 58921, 58949, 59165, 59168, 59174, 59186, 60076, 60387, 60429, 60432, 60435, 60437, 60444, 60447, 60465, 60466, 60470, 60474, and 60534.

59253 (COO–3538-1) STUDY OF THE IB-IIB BETA PHASE ALLOYS. Final Report. Muldawer, Leonard; Amar, Henri (Temple Univ., Philadelphia, Pa.). 31 Jul 1972. Contract AT-(30-1)-3538. 13p. Dep. NTIS.

The results of the program of research from 1961 to 1972 are reviewed. The problems studied, apparatus used, and resulting publications and dissertations are included. It is felt that significant progress in the understanding of IB–IIB alloys (β and α) has been achieved. Special attention was given to optical properties, transport properties (electric conductivity, Hall effect), crystal structure (ordering, lattice constants, and phase transformations) and critical phenomena (specific heat, electric conductivity, crystallographic order). The alloys studied include β'-CuZn, β'-AgZn, ζ-AgZn, β'-AuCd, β''-AuCd, β'-AuZn, α-CuAl, α-AuZn, α-AgZn, α-AgCd, Cu_3Au, CuAu, and ternaries, such as CuZn–AuZn, AgZn–AuZn, and AgCd–AuCd. (P.C.H.)

59254 (JUL–871-RB) CATALOG OF MELTING BODIES OF METALLIC MATERIAL FOR THE DETERMINATION OF TEMPERATURES IN THE REGION FROM 30 TO 1555^{0}C. Presser, Karl-Heinz (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorbauelemente). Jun 1972. 155p. (In German). Dep. NTIS (U. S. Sales Only).

For the purpose of an indirect, approximate determination of temperatures in the region of 30 to 1555°C, 143 different melting bodies of metallic material (18 pure metals, 88 alloys with melting point, 37 alloys with a melting interval of nearly 20°C), their constituents, and compositions are given. The size of the melting bodies varies between 1 mm and 10 mm. Suitable forms for the melting bodies are given. The melting bodies may only be applied in capsules, surrounded by a protecting atmosphere. The appropriate capsule material is quartz and aluminum oxide. Hydrogen is particularly appropriate as the protecting atmosphere. Also, for surfaces of melting bodies nearly free from metal impurifications, the empirically determined temperature of variation and the response sensitivity of miniature melting bodies is given in relation to the melting point or the melting interval. The reproducibility of the temperature of form variation was lower than ±2% in most cases. (auth)

59255 (NP–19453) DECOMPOSITION OF AUSTENITE IN VANADIUM-TREATED FINE GRAIN STEELS. Heikkinen, Veikko (Helsinki Univ. of Technology, Otaniemi (Finland). Lab. of Physical Metallurgy). 1972. 67p. Dep. NTIS (U. S. Sales Only).

Thesis.

Two-dimensional granular colonies and planar band colonies as well as transformation twins, formed during continuous cooling or isothermal treatment after austenizing at 910, 1100, or 1250°C, were studied by means of electron microscopy and x-ray measurements in a vanadium- and vanadium/nitrogen-treated fine grain steel. The main emphasis was on the structures generated during slow cooling from 1100°C. It was found that each of the structural elements in question were formed within different temperature intervals. The formation mechanisms of the colonies and twins are discussed in detail. On the basis of the results obtained the following conclusions have been drawn: In a fine grain steel, vanadium forms the carbonitride V(D,N) with an NaCl-type structure. The stability of V(C,N) increases with an increasing nitrogen content of the alloy. Essentially two-dimensional granular colonies consisting of V(C,N) granules embedded in ferrite matrix are formed at the repeatedly moving γ/α interface in connection with the decomposition of austenite in the temperature interval 650 to 770°C. At high temperatures, i.e., above 750°C some of the granular colonies are extended to three-dimensional rod colonies. Planar band colonies consisting of V(C,N) bands embedded in the ferrite matrix are generated above 770°C. The bands are formed at the ordered parts of the γ/α interface, this being displaced by means of ledge mechanism. In the direction normal to the bands there exists a misfit giving rise to a stress field in the matrix. The stress relaxation tendency may result in the formation of twins which, once nucleated, continue to grow in length in conjunction with the movement of the γ/α interface. Transformation twins are prismatic crystals entirely bounded by three coherent $\{112\}$ twin boundaries which belong to the same $\langle 111 \rangle$ zone. The coherent V(C,N) bands loose their coherency when the ferrite matrix is deformed. The twin boundaries strongly resist the movement of the dislocations. (auth) (Finland)

59256 (ORNL–4813) NEW PLATINUM–RHODIUM–TUNGSTEN ALLOYS FOR SPACE ISOTOPIC HEAT SOURCES. Inouye, H.; Liu, C. T.; Donnelly, R. G. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 36p. Dep. NTIS.

New platinum alloys were developed as possible encapsulating materials in space isotopic heat sources. Alloys containing 26 to 30% Rh, 6 to 10% W, 0 to 1.0% Hf, and 0 to 0.5% Ti (by weight) are only slightly less oxidation resistant than platinum up to 1200°C, have higher tensile strengths than TZM or Pt-30% Rh at all temperatures, and are as strong as iridium but somewhat weaker than T-111 at 1316°C. Limited results suggest that these new alloys are readily fabricable, are compatible with heat source environments to at least 1100°C, and possess the highest toughness and post-impact oxidation resistance of all candidate alloys. (auth)

59257 (ORNL–TM–3917) HIGH-TEMPERATURE STRUCTURAL DESIGN METHODS FOR LMFBR COMPONENTS. Quarterly Progress Report for Period Ending June 30, 1972. Greenstreet, W. L.; Corum, J. M.; Pugh, C. E. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 145p. Dep. NTIS.

Accomplishments in a program to develop high-temperature structural design methods for LMFBR vessels, components, and core structures are summarized. The program has as its goal the development of a verified high-temperature design technology applicable to the long-term operating conditions expected for LMFBR systems. Although the ultimate objective is to develop verified methods and criteria for reliably designing for high temperatures and long life, near-term efforts are largely concentrated on establishing and validating methods and criteria to be used, on an interim basis, for FFTF and which are based on the current, largely unverified, state-of-the-art. The overall program is divided into a number of tasks which are being carried out with the participation and cooperation of industrial groups, universities, and design code bodies. Progress on these tasks is described. 40 references. (auth)

59258 (WCAP–7926) EFFECTS ON FRACTURE MECHANICS PARAMETERS OF DISPLACEMENT MEASUREMENT GEOMETRY FOR VARYING SPECIMEN SIZES. Heavy Section Steel Technology Program Technical or Programmatic Manuscript No. 18. Legge, S. A. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Jun 1972. Subcontract No. 3196. 17p. Dep. NTIS.

For Oak Ridge National Lab., Tenn.

The effect of varying displacement gage position and gage length on compact tension specimens of steel was examined specifically in reference to the Westinghouse method of testing. The evaluation has been applied to lower-bound K_{Ic} calculations associated with the Equivalent Energy Theory and, thus, it reflects the effects of significant plasticity. Comparisons of measurement geometries for 1T, 2T, 4T, and 6T compact tension specimens showed that the lower bound calculations are insensitive to these variations. (auth)

59259 (Y–1850) PRECIPITATION HARDENING OF URANIUM–TITANIUM ALLOYS CONTAINING LESS THAN 1.0 WEIGHT PERCENT TITANIUM. Ammons, A. M. (Oak Ridge Y-12 Plant, Tenn. (USA)). 25 Sep 1972. Contract W-7405-eng-26. 91p. Dep. NTIS.

The strengthening mechanisms in the uranium–titanium alloys containing less than 1.0 wt% titanium were studied. Small castings of the uranium–0.5 wt% titanium alloy were heat treated and the mechanical properties were determined. The response of the alloy to aging was followed with metallography, microhardness, lattice parameter measurements, and electron microscopy. Gamma quenching of the alloy produces a strong, ductile material with a yield strength of 79.4 ksi and 26% elongation. The single phase acicular microstructure is designated α_a' due to the contraction of the b parameter of α-uranium. Subsequent aging of γ-quenched alloy produces an increase in hardness and yield strength with a decrease in ductility. The b parameter continues to contract up to 72 h at 400°C indicating a further clustering of the titanium atoms, i.e., Guinier–Preston (GP) zone information. Afte aging for 6 h at 400°C, small zones of U_2Ti 25 to 40 Å in diameter were observed in the microstructure with transmission electron microscopy. Aging for 72 h at 400°C produced a maximum hardness of 511 DPH and a maximum strength of 145.2 ksi. The transmission electron microstructure showed a basket-weave structure caused by the overlap of the strain fields associated with the U_2Ti precipitate. Stereographic analysis indicates the habit plane of the precipitates is the (010) of α-uranium. The orientation relationship between the precipitate and matrix is $(01\bar{1}0)_{U_2Ti} \parallel (010)_{\alpha\text{-U}}$ with $[0001]_{U_2Ti} \parallel [100]_{\alpha\text{-U}}$. In addition the $[2\bar{1}\bar{1}0]_{U_2Ti} \parallel [001]_{\alpha\text{-U}}$. Continued aging past maximum hardness, produces growth of the precipitates particularly at grain boundaries. The optical metallography shows a two phase structure with the grain boundaries being equilibrium α plus U_2Ti while the center of the grains are untransformed α'_a. The transformation at long aging times proceeds along the martensitic platelets and produces precipitates less than 2 μ in diameter after 240 h at 600°C. (auth)

59260 DECOMPOSITION OF GAMMA PHASE IN A URANIUM—9.5 WT. PERCENT NIOBIUM ALLOY. Djuric, B. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Nucl. Mater.; 44: No. 2, 207-14(Aug 1972).

The isothermal decomposition of the gamma solid solution of a U—9.5 wt % Nb alloy was followed in the temperature interval 450 to 600°C, using x-ray diffraction and metallography. The decomposition proceeded in two steps. The first was a discontinuous precipitation of a lamellar two-phase aggregate composed of alpha solid solution and a metastable gamma phase. The metastable gamma had a constant composition at given temperature. After longer annealing it decomposed eutectoidally into the equilibrium $\alpha + \gamma_2$ phase mixture. During this process a modification of the original lamellar microstructure took place. (auth)

59261 WELDABILITY OF NEWLY DEVELOPED 2.25Cr—1Mo—Nb STEEL. Mochizuki, Hiroji (Kawasaki Heavy Industries, Ltd., Kobe, Japan); Terai, Kiyoshi; Nakai, Yasuo; Murakami, Takashi; Shimizu, Shigeki. Kawasaki Giho; No. 42, 48-56(Jul 1971). (In Japanese).

In fabrication of steam generators for sodium-cooled fast breeder reactors, it is very important to select suitable material and establish optimum welding procedures. In this case, expensive austenitic stainless steel is used for the primary and the secondary sodium system and comparatively low-cost ferritic low alloy steel is regarded as suitable for the steam and water system, from the mechanical, physical, chemical, and economical points of view. In this selection, however, the troublesome problem is carbon migration from ferritic to austenitic steel through sodium. To solve this problem, an advanced 2.25 Cr—1Mo steel containing niobium was developed. The results are summarized as follows: there was no appreciable difference from conventional 2.25 Cr—1Mo steel in weldability and the weld-joint tests at service temperature showed superiority over conventional 2.25 Cr—1Mo steel. (auth) (Japan)

59262 MECHANICAL PROPERTIES OF THE DELTA PHASE OF PLUTONIUM AT VERY LOW TEMPERATURES. Lefort, A. (CEN, Fontenay-aux-Roses, France). J. Nucl. Mater.; 44: No. 2, 153-60(Aug 1972).

An apparatus was designed, to function inside a glove-box, for performing tensile tests on specimens of plutonium in the stabilized delta phase at very low temperatures (4 to 300 K). From the stress-strain plots, the Young's modulus and elastic limit of each specimen was determined for temperatures in the range 4 to 300 K. The variation of Young's modulus with temperature was interpreted in terms of a postulated interaction of interstitials, formed by self-irradiation, with dislocations. (auth)

59263 ESTIMATION OF THE EFFECT OF THE STRESSED STATE OF A COATING ON THE STRENGTH AND DEFORMABILITY OF A COMPOSITION MATERIAL. Kozub, Yu. I. Probl. Prochnosti; No. 7, 42-6(1971).

Results of studying the short-term strength and creep of molybdenum with different diffusion coatings are presented. The stressed state of the coatings is analyzed. An effort was made to explain the mechanism of the effect of the coating on the properties of the base during tests in a vacuum and an oxidizing medium. It is established that the characteristic of the limiting state in the case of prolonged tests is the critical deformation which depends on the composition of the applied coating and the operating temperature. A procedure is presented for estimating the supporting capacity of the structural elements made of materials with critical strain protective coatings. By joint application of the results of the theoretical and experimental studies of such indexes as the composition reliability, it is possible to establish the fitness criteria first at the construction material level and then at the construction element level considering the shape and size of the product and other factors. Graphs are presented showing the temperature dependencies of the ultimate strength of the initial molybdenum and molybdenum with test coatings Nos. 1 and 2 based on silicon in a vacuum and in an oxidizing medium, the temperature dependencies of the deformability of the initial molybdenum in a vacuum, molybdenum with coatings numbers 1 and 2 based on silicon in a vacuum and in an oxidizing medium, and the temperature dependence of the critical deformation when testing molybdenum with a coating based on silicon for creep in an oxidizing medium. (JPRS)

59264 CONTRIBUTION TO THE EVALUATION OF THE SAMPLE ABSORPTION CURRENT IN DIFFUSION STUDIES WITH THE ELECTRON BEAM MICROANALYSIS. Triebel, H.; Kaltenbrunner, J. (Technische Hochschule, Vienna). Mikrochim. Acta; No. 3, 424-33(1972). (In German).

A study was conducted of the analytical evaluation of the sample absorption current in the diffusion studies with the aid of the electron beam microanalysis in the case of the binary system titanium—molybdenum. It is shown that the values obtained by means of sample current curves agree satisfactorily with these obtained from the element specific impulse rates. (auth)

59265 VISCOSITY AND ELECTRICAL RESISTANCE OF INDIUM—MERCURY ALLOYS. Kononenko, V. I.; Yatsenko, S. P.; Sudakov, V. A.; Kozin, L. F.; Khromtsov, V. V. (Inst. of Chemistry, Sverdlovsk, USSR). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 2, 188-90(Feb 1972).

Translated from Zh. Fiz. Khim.; 46: No. 2, 321-4(Feb 1972).

The viscosity ν and the resistivity ρ of liquid indium—mercury alloys were measured over the range 293—713°K by a combined electrodeless relative method using an ampoule. Two clearly defined maxima are observed on the viscosity isotherms at indium concentrations of 20 and 60 at. %, which represent the maintenance of short-range order as in the compounds $InHg_4$ and InHg. Values of the resistance agree well with those calculated by Adams. A comparison was made of the variation in thermodynamic properties and in viscosity in this system, and the viscosity was calculated for all the alloys at 433°K by means of the equations of Koledov, Moelwyn—Hughes, and Rother and Bittrich. (auth)

59266 KINETICS OF DISSOLUTION OF TWO-PHASE ALLOYS IN MOLTEN METALS. Korehagin, A. I.; Sergeev, A. M.; Temnykh, V. I. (Krasnoyarsk Polytechnic Inst., USSR). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 2, 212-14(Feb 1972).

Translated from Zh. Fiz. Khim.; 46: No. 2, 366-8(Feb 1972).

The dissolution of two-phase alloys under the conditions of a two-phase regime was examined. Transverse diffusion makes a significant contribution to the rate of the process. The effect of the transverse diffusion depends on the degree of dispersion of the structure and intensity of stirring of the liquid, and this can be used for determining the characteristics of the boundary layer. In, Ga, and Hg were studied as solvents. (auth)

59267 VAPOUR PRESSURE OF SOLID CADMIUM. Muradova, O. N.; Muradov, V. G. (Ul'yanovsk State Pedagogic Inst., USSR). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 2, 282-3(Feb 1972).

Translated from Zh. Fiz. Khim.; 46: No. 2, 492-3(Feb 1972).

The vapor pressure of solid cadmium was measured between 93.5 and 132°C by the atomic absorption method. The values obtained are in the range 8.3×10^{-8} to 3.0×10^{-6} torr and are described by the equation $\lg p = (9.20 \pm 0.50) - (5940 \pm 200)\,T^{-1}$. (auth)

59268 DATA ON ALLOY STRUCTURE AT 2000°C IN THE TERNARY SYSTEM Nb—C—Re. Ordan'yan, S. S.; Vil'k, Yu. N.; Avgustinik, A. I. (Leningrad Technological Inst.). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 2, 334-5(Feb 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 2, 383-4(Feb 1972).

In studies on the Nb—C—Re system, no ternary compounds were observed. A characteristic feature was the low solubility of Re in the carbide phases of Nb, which is comparable with that in TiC, ZrC, and TaC, but markedly less than in vanadium carbide. The lattice constant of the χ-phase decreased somewhat with increasing Re concentration. For alloys in equilibrium with the NbC_x phase the lattice constant of the χ-phase was 9.64 Å, but for the three-phase region χ-phase-NbC_x-Re it was 9.62 Å. An analysis of the x-ray diffraction pattern of alloy 10 indicated a slight decrease of the lattice constant c of the hexagonal Nb_2C phase in comparison with pure Nb_2C, which might be due to solution of Re and to an increase in the number of carbon defects in Nb_2C. (P.C.H.)

59269 ELECTROMOTIVE FORCE STUDY OF THE THERMODYNAMICS OF GADOLINIUM—GALLIUM ALLOYS. Shkol'nikova, T. M.; Bayanov, A. P.; Serebrennikov, V. V. (Tomsk State Univ., USSR). Russ. J. Phys. Chem. (Engl. Transl.); 46: No. 3, 346-8(Mar 1972).

Translated from Zh. Fiz. Khim.; 46: No. 3, 602-5(Mar 1972).

The thermodynamic properties of liquid gallium—gadolinium alloys at gadolinium concentrations ranging from 0.05 to 10 wt % were investigated in the range 400 to 700°C by a method involving the measurement of the emf's of the concentration cell $-\mathrm{Mo}|\mathrm{Gd}\,(\mathrm{solid})\,|\,(\mathrm{LiCl}-\mathrm{KCl}) + 2\ \mathrm{wt}\ \%\ \mathrm{GdCl_3}\,|\,(\mathrm{Gd}-\mathrm{Ga})(\mathrm{liq.})|\mathrm{Mo}+$. Large negative deviations from ideality were observed in the melt. The Gibbs free energy, the enthalpy, and the entropy of formation of the intermetallic compound $GdGa_2$ were calculated. With increase of temperature from 400 to 700°C, the solubility of gadolinium in gallium increased from 0.20 to 2.21 wt %. (auth)

59270 DETERMINATION OF GASES IN HIGH MELTING METALS WITH AN ELECTRON MICROPROBE. Kuznetsov, L. B.; Ugaste, Yu. E. (Inst. of Metallurgy, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 3, 365-7(Mar 1972).

Translated from Zavod. Lab.; 38: No. 3, 294-7(Mar 1972).

The use of electron microprobes to determine the dissolution states of Mo and W in baths containing liquid Fe, Ni, Co, and Sn in various combinations was investigated for analysis of Mo and W for oxygen. It was found that Co-base baths are best for use in determination of O in W. Positive results for Mo using this method were not obtained. Direct fusion using graphite crucibles is recommended for Mo. (J.R.D.)

59271 CONSTRUCTION OF THE LIQUIDUS LINES OF STATE DIAGRAMS OF BINARY SYSTEMS USING THE CONTACT MELTING METHOD (EXCHANGE OF EXPERIENCE). Akhkubekov, A. A.; Savvin, V. S.; Savintsev, P. A.; Rogov, V. I. (Kabardino-Balkarsk State Univ., USSR). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 2, 257-8(Feb 1972).

Translated from Zavod. Lab.; 38: No. 2, 208(Feb 1972).

A method for construction of liquidus diagram lines by contact melting is described. The method is used to establish the liquidus lines in fusibility diagrams for In–Ga, Sn–Ga, and Zn–Ga systems. Data on points of the liquidus in these systems are presented tabularly. (J.R.D.)

59272 EVALUATION OF THE GRAIN SIZE OF A TUNGSTEN COATING DEPOSITED FROM THE GASEOUS PHASE. Andreev, Yu. V.; Kleiner, L. M.; Chernikov, Yu. P.; Venkova, R. S. Ind. Lab. (USSR) (Engl. Transl.); 38: No. 2, 236-41(Feb 1972).

Translated from Zavod. Lab.; 38: No. 2, 191-6(Feb 1972).

A method of evaluating grain size in cross sectional slices of W specimens is described. For equiaxial, acicular, and branching structures, the grain size was evaluated in points by comparison of grains visible in the microscope with an established standard scale. Using this method, evaluation of grain size in cross sectional slices can be finished more quickly since only one slice is required for the entire cross section. (J.R.D.)

59273 WHY METALS FAIL. Barer, R. D.; Peters, B. F. New York; Gordon and Breach, Science Publishers, Inc. (1970). 350p.

Common failure mechanisms, such as brittle failure, fatigue, corrosion fatigue, stress corrosion cracking, crevice corrosion and galvanic corrosion and the metallurgists tools for physical and non-destructive testing are discussed. Case histories for boiler tubes, boilers, heat exchangers, pressure vessels, valves, piping and piping systems, bolts and fittings, wire ropes, structural and fittings, pumps and fittings, vehicles, internal combustion, bearings, springs, propellers and anchors, and miscellaneous failures are also discussed. References and supplementary sources are listed. (P.C.H.)

59274 INVESTIGATION OF PROPERTIES OF POROUS MATERIAL OF NICKEL–MOLYBDENUM AND NICKEL–CHROMIUM–MOLYBDENUM ALLOYS. Solonin, S. M.; Chernyshev L. I.; Fedorchenko, I. M. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 6, 36-41(Jun 1972). (In Russian).

The physicomechanical, hydraulic, and corrosion properties of porous materials of nickel–molybdenum and nickel–chromium–molybdenum powder alloys were investigated. It was established that porous alloys of the Ni–30 Mo possessed a high stability in boiling muriatic acid; alloys of Ni–15 Cr–15 Mo had a sufficiently high stability in nitric and muriatic acids at room temperature. (auth)

59275 STUDY OF FERRITE MORPHOLOGY IN AUSTENITIC STAINLESS STEEL WELDMENTS. Goodwin, G. M.; Cole, N. C.; Slaughter, G. M. (Oak Ridge National Lab., Tenn.). Weld. J. (N. Y.); 51: No. 9, 425s-9s(Sep 1972).

The limited amount of data available on the stress-rupture properties of austenitic stainless steel weldments show a large scatter in ductility; much of the data show less than 10% total elongation. It seems highly probable that the ferrite morphology significantly influences creep ductility and that variations in morphology account for much of the scatter in data. The quantitative television microscope (QTM) was used extensively and found to be a precise method for measuring ferrite contents in metallographic cross sections of the weldments. It was noted, however, that metallographic etching technique affected the reproducibility of the results as did several equipment variables including the discrimination threshold setting. The difference in chemical composition of the filler metals used for each of four welds caused the overall mean ferrite content to vary from 3.1 to 8.2% as measured by the QTM. These results could not be accurately predicted using the existing Schaeffler, McKay, or similar diagrams. Further investigation revealed substantial variations in ferrite content from weld to weld produced under identical conditions, from location to location along the center line of a particular weld, and from point to point within a particular transverse-weld cross section. In addition to ferrite content, the distribution of ferrite present was also seen to vary substantially in each of the mentioned locations. In all instances, the ferrite was located at dendritic or cellular dendritic substructure boundaries, forming a more or less continuous network. The average dimensions and appearance of this network were highly variable from weld to weld and from location to location within a particular weld. Initial results show that mechanical behavior can be correlated with ferrite morphology and that the scatter in properties can be reduced considerably by its consideration. (auth)

59276 DETERMINATION OF THE COMPONENT ACTIVITIES IN THE SYSTEM In–Ga USING A SOLID OXIDE ELECTROLYTE TECHNIQUE. Klinedinst, K. A.; Rao, M. V.; Stevenson, D. A. (Stanford Univ., Calif.). J. Electrochem. Soc.; 119: No. 9, 1261-5(Sep 1972).

An electrolytic technique utilizing the cell, Pt/W/Ga, β-Ga_2O_3/calcia stabilized zirconia/Ga–In, β-Ga_2O_3/W/Pt, has been used to measure activities of Ga in liquid In–Ga alloys in the temperature range 800 to 950°C. The Ga activities and the In activities, calculated from the Gibbs–Duhem equation, show modest positive deviation from Raoult's law. The activities are compared with previously measured and computed values. The parameter α_{GaIn} (defined by $\ln \gamma_{Ga}/[1-N_{Ga}]^2$) is seen to have a very small composition dependence in the temperature range studied. The partial molar excess entropies of solution of Ga, calculated using the measured free energies and previously measured values for the heats of mixing, are demonstrated to be negative and small. (auth)

59277 BENDING TITANIUM AND BERYLLIUM SHEET IN PRESSURIZED FLUID. Myer, G. E.; Fiorentino, R. J. (Battelle Memorial Lab., Columbus, Ohio). J. Basic Eng.; 94: No. 3, 589-94(Sep 1972).

Bend tests were conducted to determine the effect of changes in ambient pressure on the minimum bend radii of titanium and beryllium sheet. Sheet specimens of commercially pure titanium, Ti–6Al–4V, Ti–8Mo–8V–2Fe–3Al (beta-titanium alloy), Ti–8Al–1Mo–1V, and 1.5 percent BeO beryllium sheet were bent using a series of bend radii in fluid pressurized up to 225,000 psi. All the materials could be bent to 1T radii well below this pressure level except Ti–8Al–1Mo–1V, and beryllium. Extrapolation of the test results indicated that these latter two material would have to be pressurized to about 260,000 psi to accommodate a 1T bend. No relationship was evident between mechanical properties of the sheet and the influence of ambient pressure on minimum bend radii. Strain and reduction in area values experienced by the sheet in bending were calculated as a function of bend radius. (auth)

59278 IRREGULARITY IN PLASTIC DEFORMATION OF A DISPERSION-HARDENING NICKEL-BASE ALLOY. Berkman, I. V.; Levin, A. E.; Lozinskii, M. G. Fiz. Khim. Obrab. Mater.; No. 3, 39-46(1972). (In Russian).

The process of intermittent deformation was studied during elongation at elevated temperatures of a Ni-base alloy containing Cr–16.1%, Mo–8.8%, W–4%, Ti–1.4%, Al–1.4%, Fe–0.4%. The temperature limits of intermittent deformation were established as 450°C as the lower limit, and 780°C as the upper. The degree of deformation increased with increase in temperature and decrease in rate. The average magnitude of the discontinuity of elongation also changed with temperature and deformation velocity; a maximum appeared at 650°C. The average time between adjacent discontinuities altered similarly. The phenomenon of discontinuous deformation is directly connected with shear in intergranular processes. (K.S.W.)

59279 INVESTIGATION OF A COPPER–ZIRCONIUM ALLOY AFTER INTERNAL OXIDATION WITH THE HELP OF AN EMISSION MICROSCOPE. Skazin, V. E.; Kernov, Yu. P.; Novokreshchenova, V. B.; Tumanova, A. V. Fiz. Khim. Obrab. Mater.; No. 3, 86-90(1972). (In Russian).

Alloys of Cu–Zr with up to 1.5% Zr were prepared in a vacuum induction furnace and a graphite crucible, and the product was forged at an initial temperature of 900°C until the desired dimensions were obtained. Alloy specimens were packed in a stainless steel tube with a powdered Cu–CuO mixture (1 : 1), and the tube was closed by welding. The contents of the sealed tube were given a 2 hr oxidizing treatment at 950°C. The alloy specimens were recovered and cold-rolled at 90% deformation. Metallographic examination with an optical microscope and an emission microscope revealed globular occlusions of ZrO_2 at grain boundaries, no recrystallization in alloys containing 0.16% Zr, and loss of the compound Cu_3Zr in alloy specimens with higher Zr content. (K.S.W.)

59280 METALLOGRAPHIC STUDY OF THE MICRO-HETEROGENEITY OF SOME NIOBIUM-BASED ALLOYS. Ozerova, E. I.; Mel'nikova, L. V. Nauch. Tr., Nauch.-Issled. Proekt. Inst. Redkomet. Prom.; 32: 28-34(1971). (In Russian).

A metallographic study of Nb-based alloys was carried out. These alloys tend to form low-angle polygonization boundaries both in the cast and wrought, as well as in the annealed, condition. (Referativnyi Zh.)

59281 CHEMICAL INHOMOGENEITY IN WELDED JOINTS OF ALUMINUM–BERYLLIUM ALLOY. Komarov, M. A.; Lobzhanidze, A. V. Fiz. Khim. Obrab. Mater.; No. 3, 91-3(1972). (In Russian).

A redistribution of Be was detected throughout the cross sections of welded joints of Al–Be alloy, so that the %Be ranged from 35 to 65. This inhomogeneity was explained by a variable solubility at the boundary of the solid-liquid state. (K.S.W.)

59282 EFFECT OF HIGH VACUUM ON THE STRUCTURE, INTERNAL FRICTION, AND SHEAR MODULUS OF REFRACTORY METALS AT HIGH TEMPERATURES. Shestopal, V. O.; Rastorguev, A. A. Fiz. Khim. Obrab. Mater.; No. 3, 140-2(1972). (In Russian).

Conditions of high-vacuum and high-temperature annealing (500 to 2500°K) of Pt, W, and Mo wires produced a "bamboo" structure with grain boundaries perpendicular to the axis of the sample. Pronounced peaks were observed in internal friction vs temperature curves for Pt and Mo, but not for W. Shear modulus of the metals was measured and discussed. (K.S.W.)

59283 VARESTRAINT TESTING OF NICKEL ALLOYS. Lingenfelter, A. C. (International Nickel Co., Inc., Huntington, W. Va.). Weld. J. (N. Y.); 51: No. 9, 430s-6s(Sep 1972).

Extensive Varestraint testing of nickel alloys has shown that the test is an effective method to evaluate the weldability of the alloys in terms of resistance to hot cracking. Good correlation was found between the degree of weldability indicated by the Varestraint test and actual welding experience for established alloys. The test method also accurately predicted the weldability of newly developed alloys. (auth)

59284 EFFECT OF STRESS CONCENTRATIONS ON THE MECHANICAL CHARACTERISTICS OF MOLYBDENUM AT NORMAL AND HIGH TEMPERATURES. Zelenyuk, E. E.; Rudenko, V. N. Probl. Prochnosti; No. 12, 96-9(Dec 1971). (In Russian).

Experimental data relating to the effects of stress concentrations on the mechanical characteristics of round Mo samples with helical and annular notches, subjected to short-term tensile tests in a vacuum at 20 to 1500°C, are presented and analyzed. The results were compared with those relating to smooth samples under the corresponding conditions. The material in question was insensitive to annular notches, but helical notches reduced its mechanical strength by up to 40% as compared with smooth samples. (Metals Abstr.)

59285 ALLOYS OF THE SYSTEM Mo–C–Ni. Freze, N. I.; Biryukova, T. A.; Murzinov, N. A. Tsvetn. Metal.; No. 7, 81-3(Jul 1972). (In Russian).

The distribution of Ni throughout ingots of Mo–C–Ni (0.01 to 0.10% Ni, 0.05 to 0.10% C, the rest Mo) was studied after different conditions of melting and casting. The change of temperature of cold brittleness of the cast metal was a function of the method of melting the sample. (tr-auth)

59286 STUDY OF THE YOUNG'S MODULUS OF SHEET MOLYBDENUM. Vitorskii, Ya. M.; Igolkina, L. S.; Malashenko, I. S.; Nadezhdin, G. N.; Tkachenko, V. G. Probl. Prochnosti; No. 11, 119-21(Nov 1971). (In Russian).

The anisotropy of the Young's modulus of textured sheet Mo of two degrees of chemical purity was studied immediately after rolling at 1000°C and also after subsequent annealing at 1000 to 1400°C. The Young's modulus exhibited a maximum at an angle of 45° to the rolling direction. This maximum was attributed to the creation of a cubic type of orientation, characterized by the parameters (100) $[\bar{0}\bar{0}1]$, in this direction. After annealing, the texture in question disappeared, and the material became elastically isotropic. (Metals Abstr.)

59287 DIFFUSION PROCESSES IN THE JOINING ZONES OF TITANIUM/NIOBIUM BIMETALS AND TITANIUM/NIOBIUM/TITANIUM TRIMETAL. Polyanskii, V. M.; Podgorskii, B. N.; Makarovets, O. D. Svar. Proizv.; No. 3, 9-10(Mar 1971). (In Russian).

The distribution of elements in the diffusion zone of weld seams of Ti/Nb and Ti/Nb/Ti composites was investigated by local spectral analysis and optical and electron microscopy. The concentration dependence of self-diffusion coefficients in the Ti/Nb system was determined; the maximum value was attained at ~7% Nb. (Metals Abstr.)

59288 β AuCd MARTENSITES. Ledbetter, H. M.; Wayman, C. M. (Univ. of Illinois, Urbana). Met. Trans.; 3: No. 9, 2349-56 (Sep 1972).

The martensites which form from β AuCd alloys were studied by x-ray diffraction using both powder and single-crystal techniques. Alloys containing 46.8 to 51.0 at. % Cd were examined. Besides the parent phase β only two other phases were observed: β' and β''. A new unit cell is proposed for β'' which has 18 atoms and trigonal-hexagonal point symmetry. All previous β'' crystal structure proposals were reviewed critically. The relationship of the β'' crystal structure to the β-to-β'' martensitic transition is discussed. (auth)

59289 DIFFUSION OF CHROMIUM AND ALUMINUM IN Ni–20Cr AND TDNiCr (Ni–20Cr–2ThO$_2$). Seltzer, M. S.; Wilcox, B. A. (Battelle Memorial Inst., Columbus, Ohio). Met. Trans.; 3: No. 9, 2357-62(Sep 1972).

Diffusion coefficients were measured for ^{51}Cr in fine- and coarse-grained TDNiCr (Ni–20Cr–2ThO$_2$) and in fine-grained Ni–20Cr in the temperature range of 1038 to 1200°C. Selective diffusivities have also been determined for specimens of these alloys which were aluminized to give an initial surface concentration of 5.8 wt % Al. Finally, diffusion coefficients for interdiffusion of aluminum in TDNiCr and Ni–20Cr have been obtained from electron probe microanalysis of the aluminized specimens. For a given grain size and temperature there is no difference in diffusivities for chromium diffusion in TDNiCr or Ni–20Cr. Diffusion coefficients increase with decreasing grain size for both alloys. Comparison of aluminum diffusion data obtained from electron microprobe profiles with radiotracer chromium diffusivities suggests that aluminum diffuses approximately three times faster than chromium in TDNiCr and Ni–20Cr. (auth)

59290 THERMODYNAMICS OF FORMATION OF COMPOUNDS IN THE Ce–Mg, Nd–Mg, Gd–Mg, Dy–Mg, Er–Mg, AND Lu–Mg BINARY SYSTEMS IN THE TEMPERATURE RANGE 650^0 TO 930^{0}K. Pahlman, J. E.; Smith, J. F. (Ames Lab., Iowa). Met. Trans.; 3: No. 9, 2423-32(Sep 1972).

The vapor pressures of magnesium over a series of two-phase alloys of Mg with Ce, Nd, Gd, Dy, Er, and Lu were measured by the Knudsen effusion technique in the temperature range 650 to 930°K. These vapor pressure measurements were combined with data concerning the terminal solubility of magnesium in the rare earths and the vapor pressure of pure magnesium to evaluate the standard free energies of formation of the twenty-four intermediate phases in these six binary systems. Trends in the data correlate with the number of unpaired 4f electrons of the lanthanon component, and the inference is that the 4f electrons make a contribution to the bonding interactions. There is also evident a shift in the pattern of the free energies of formation of the phases with the shift occurring as the atomic number of the lanthanon component is increased. This implies modification of the bonding interactions by some additional factor which might be either a size factor or a crystal-environmental dependence of the strength of the 4f bonding contributions. Experiments are proposed to distinguish between the possibilities. (auth)

59291 OPTIMIZATION OF THE RANGE OF ELASTIC BEHAVIOR OF UNIDIRECTIONAL COMPOSITES BY PRESTRAINING. Heckel, R. W. (Carnegie-Mellon Univ., Pittsburgh); Zaehring, R. J.; Cheskis, H. P. Met. Trans.; 3: No. 9, 2507-13(Sep 1972).

The effects of tensile prestrain on the stage I tensile yield stress were studied both analytically and experimentally for composites whose stress-strain curves obey the rule of mixtures. The mathematical analysis provides a means for calculating the optimum amount of prestrain, the residual stresses (in the direction of the fibers) in the matrix and fiber materials after unloading from the prestraining, and the stage I yield stress in the composite after the prestrain treatment. It was found that the improvement in stage I yield stress by prestraining is due to the development of negative residual stresses in the matrix. The stage I yield stress in composites with negligible residual stresses in the as-fabricated condition can usually be improved by a factor of two by prestraining; the amount of improvement is even greater if the as-fabricated composites have the usual state of residual stress, i.e., tension in the matrix. Experimental studies on 2024 aluminum-tungsten composites (filament-wound; hot-pressed) having tungsten fiber volume fractions between 0.08 and 0.40 verified the mathematical analysis. The stage I yield stresses measured in these composites after a prestrain of 4.2×10^{-3} were in good agreement with predicted values. Improvements of up to a factor of six were found in the stage I yield stress as a result of prestraining. (auth)

59292 DECARBURIZATION KINETICS OF LOW ALLOY FERRITIC STEELS IN SODIUM. Krankota, J. L.; Armijo, J. S. (General Electric Co., San Jose, Calif.). Met. Trans.; 3: No. 9, 2515-23(Sep 1972).

The rates of decarburization of low alloy and plain carbon steels in static, isothermal sodium were measured over the temperature range 1000 to 1300°F. Low alloy steels studied in these tests were 2¼ Cr–1 Mo (T22), 2¼ Cr–1 Mo–1 Nb, and 2¼ Cr–1 Mo–low carbon (0.015 C). Plain carbon steels studied were 1020, 1040, and 1095. Periodic measurements of the specific carbon loss (mass of carbon lost per unit surface area of specimen) revealed that the decarburization of normal $2\frac{1}{4}$ Cr−1 Mo steel is controlled by diffusivity and solubility of carbon in the matrix. Decarburization rate constants measured for the normal $2\frac{1}{4}$ Cr−1 Mo steel were found to be in good agreement with rate constants calculated from data reported previously. Tests of modified $2\frac{1}{4}$ Cr−1 Mo steels showed that: the carbon content of the niobium-stabilized steel will either remain unchanged or will increase; and the low carbon steel will decarburize slightly during exposures in the same sodium systems which produce rapid decarburization of the steel with normal amounts of carbon. Decarburization tests on plain carbon steels revealed that both the depths of the decarburized layer and the specific carbon losses were controlled by diffusivity and solubility in the matrix. Comparison of the measured decarburization rate constants with theoretical values (based on a moving-boundary diffusion process) was in good agreement. These data were used to calculate the carbon content at the surfaces of the steels during decarburization in the liquid and vapor phases of a sodium system. It was demonstrated that plain carbon steels can serve as carbon monitors for sodium systems. (auth)

59293 SURFACE SELF-DIFFUSION OF Mo, Cb(Nb), AND Re. Allen, B. C. (Battelle Memorial Inst. Columbus, Ohio). Met. Trans.; 3: No. 9, 2544-7(Sep 1972).

Surface self-diffusion of Mo, Nb, and Re was studied by analysis of grain boundary grooving kinetics. The general relations found for bcc Mo and Nb and cph Re were similar to those previously reported for fcc (110) Cu and Ni. On the basis of a terrace-ledge-kink model, surface diffusion takes place at low temperatures by the migration of single defects, either terrace vacancies or adatoms. In this case previous calculations for Cu indicated low values of Q_s, activities energy, and D_0 which approximate experimental results. At higher temperatures, the logarithm of surface defect concentration no longer was linear in 1/T but increased at a faster rate due to surface roughening. As the temperature increased above 0.8 to 0.9 T_M, surface diffusion was further enhanced by motion of complex multiple defects up to T_M. (P.C.H.)

59294 DOPANT OBSERVATIONS IN THIN FOILS OF ANNEALED TUNGSTEN WIRE. Snow, D. B. (General Electric Co., Cleveland). Met. Trans.; 3: No. 9, 2553-4(Sep 1972).

Thin foil specimens prepared from annealed wire were examined with an electron microscope equipped with a goniometer stage and an anticontamination device. They were found to contain rows of enclosed bubbles which varied in size from 50 to 1200Å in dia. The most striking characteristic displayed by most, but not all, of the bubbles was that they contained a small quantity of rapidly moving liquid. There was no indication that the degree of beam heating that caused the entrapped material to melt and oscillate was greater than normal. The results indicated that dope in condensed form is present after high-temperature annealing. The extremely low melting point of the entrapped material suggests that it is K (mp 64°C). This hypothesis is supported by the presence of K in the doping chemicals, and in fine wire to the extent of 60 to 100 wt ppM. The large atomic size and consequent low diffusivity of K in W explain its presence as a discrete phase in fine wire despite many opportunities for homogenization during processing. The mechanism by which the cessation of dopant motion occurs during observation in the electron microscope was not apparent. (P.C.H.)

59295 Zr Hf NEWSLETTER, SEPTEMBER 1972. Akron, N. Y.; AMAX Specialty Metals Division (1972). 18p.

Properties of zirconate ceramics for use in electronic devices are reviewed. Information is also included on properties, production, and uses of Zr metal, Zr alloys, and Zr oxides, borides, carbides, hydrides, nitrides, selenides, silicides, and sulfides. 405 references are included. (J.R.D.)

59296 TUNGSTEN NEWS, OCTOBER 1972. Tungsten News; 1-18(Oct 1972).

Information and data are reviewed on properties, production, and uses of W metal W alloys, W additions to other alloys, organic W compounds, and inorganic W compounds. (327 references) (J.R.D.)

59297 FUTURE DEVELOPMENT OF CAST COMPOSITE [EUTECTIC ALLOY] MATERIALS. Balandin, G. F.; Zabolotskii, A. A. Liteinoe Proizvod.; No. 3, 4-7(Mar 1971). (In Russian).

High-temperature mechanical properties of the eutectic alloys Cu−Cr, Ni−Ni_3Nb, Nb−Nb_2C, and Al−Al_3Ni obtained by means of directional crystallization were studied. The strength of shaped castings made from eutectic alloy Al−Al_3Ni was increased two to three times after unidirectional crystallization. Different methods for obtaining castings with oriented structure are mentioned. (Metals Abstr.)

59298 NEW INTERMETALLIC COMPOUNDS OF THE TYPE $MgZn_2$ IN THE SYSTEM Zr[Hf]−V−Ru. Akhverdyan, M. M.; Burnasheva, V. V.; Gladyshevskii, E. I.; Sokolovaskaya, E. M.; Raevskaya, M. V. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 3, 350-1(1972). (In Russian).

A new intermetallic compound of the $MgZn_2$ type was identified with the composition $ZrRu_{0,5}V_{1,5}$ and $HfRu_{0,5}V_{1,5}$, lattice parameters being a = 5.30 Å, c = 8.58 Å and a = 5.18 Å, c = 8.40 Å, respectively. Alloys containing 31 to 36 at. % Zr[Hf] and 15 to 25 at. % Ru were investigated by x-ray analysis. (auth)

59299 THEORY OF THE DIFFUSION OF HYDROGEN IN METALS. Stoneham, A. M. (Atomic Energy Research Establishment, Harwell, Eng.). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 816-23(Aug 1972).

The various theories of the motion of light interstitials in metals are reviewed. The formulation of quantum theories and their relation to each other and to the classical theories is discussed. The physical assumptions are summarised, and a comparison of theory and experiment is made. The theory successfully predicts (1) the distinction between bcc and fcc host lattices, (2) the relation between activation energy and volume of solution in bcc hosts, (3) the absolute magnitudes of the activation energies, (4) the temperature dependence of the diffusion rate, (5) the existence of isotope effects in electro- and thermomigration, and (6) the Zener relations. Topics which are not yet understood are discussed. (auth)

59300 DIFFUSION OF HYDROGEN IN METALS. Birnbaum, H. K.; Wert, C. A. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Ber. Bunsenges. Phys. Chem.; 76: No. 8, 806-16(Aug 1972).

Published measurements of the diffusion of hydrogen in fcc metals are summarized with particular emphasis on the isotope effect. The observations are generally consistent with the usual rate theory model but with the energy levels in both the equilibrium site and the saddle point quantized according to an Einstein oscillator. Not all data fit this scheme, however, diffusion in Pd being a notable exception. Published work for the bcc metals shows much less consistency; surface effects and internal trapping at defects and impurities are apparently of over-riding importance. A summary of measurements of diffusion of hydrogen in liquid metals is also made. (auth)

59301 THERMODYNAMIC PROPERTIES OF ALLOYS IN THE SYSTEM W−Ni. Meshkov, L. L.; Guzei, L. S.; Kazakov, V. A.; Sokolovskaya, E. M. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 3, 351-2(1972). (In Russian).

Alloys in the system W−Ni were studied by the emf method using galvanic cells with a separate gas space over the electrodes. The activities of W and Ni and thermodynamic functions of mixing at 1173°K were calculated. Thermodynamic functions of Ni_4W were calculated using available calorimetric data as follows: $\Delta H^\circ_{298} = -1480$ cal/at. wt. $\Delta G^\circ_{298} = -1560$ cal/at. wt. $\Delta S^\circ_{298} = 0.07$ cal/at. wt. grad. (auth)

59302 ELECTROCHEMICAL METHODS FOR DIFFUSION MEASUREMENTS. Zuechner, H.; Boes, N. (Univ., Muenster, Ger.). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 783-90(Aug 1972).

The hydrogen pressure at the surface of a metal sheet, e.g., a palladium foil immersed in an electrolyte, can be measured by means of the electrochemical potential. With proper activation of the metal surface the partition equilibrium between hydrogen dissolved in the metal and in the electrolyte prevails at all times. This yields the relationship between the atomic ratio H/Me within the metal and the electrochemical potential. Detailed description of two electrochemical time-lag methods, the step and the pulse technique, which have been used to investigate the diffusion of hydrogen and deuterium in Pd and Pd/Ag alloys up to 60 percent silver content and more recently in Ta are described. With simple equipment the dependence of the diffusion coefficient on hydrogen concentration from extremely low pressures up to one atmosphere could be measured very precisely. The values obtained with these convenient methods range from 10^{-6} cm^2 s^{-1} in pure Pd to 10^{-10} cm^2 s^{-1} in Pd/Ag 40/60. Furthermore the methods are sensitive enough to yield the differences in diffusion coefficients of H and D in these alloys. (auth)

59303 GORSKY EFFECT. Voelkl, J. (Kernforschungsanlage, Juelich, Ger.). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 797-805(Aug 1972).

The application of the diffusional relaxation process, called Gorsky effect, on hydrogen-metal systems is reviewed. A transport property, namely the diffusion coefficient of hydrogen and its isotopes in metals, and an equilibrium property, namely the derivative of the chemical potential of the solutes relative to the density, $\partial\mu/\partial\rho$, can be determined from Gorsky-relaxation measurements. A survey on experiments performed up to the present is presented. (auth)

59304 NON-IDEAL SOLUTION BEHAVIOR OF HYDROGEN IN METALS. Brodowsky, H. (Univ., Muenster, Ger.). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 740-6(Aug 1972).

Hydrogen solubility in Pd and in Pd–Rh, Pd–Ag, and Ag–Cd alloys is related to the position of the Fermi level and to clustering, brought about by lattice strain. The clustering model also requires the existence of specific heat anomalies observed in Pd–H and Ta–H. (auth)

59305 CELL SOLIDIFICATION OF Bi–Cd EUTECTICS: PLANE FRONT/CELL TRANSITION AND CELL DIMENSION MEASUREMENTS. Hamar, R.; Durand, F. (Ecole Nationale Superieure, Grenoble, France). Mem. Sci. Rev. Met.; 69: No. 2, 151-8(Feb 1972). (In French). (CONF-700941-9).

From Meeting on metallurgy; Paris, France (28 Sep 1970).

The controlled solidification of Bi–Cd alloys containing Sn was studied using optical microscopy. The plane front/cell transition is in accordance with the supercooling criterion with the Chadwick modification. The cell dimensions follow an empirical law. (France)

59306 STUDY OF THE VARIATIONS OF THE OXYGEN DIFFUSION COEFFICIENT IN Zr_α INDUCED BY THE VARIATION OF THE ELEMENTARY JUMP LENGTH WITH THE OXYGEN CONCENTRATION. Boisot, Pierre; Beranger, Gerard; Lacombe, Paul (Univ. Paris, Orsay, France). Compt. Rend., Ser. C; 275: No. 2, 91-4(10 Jul 1972). (In French).

The function $C(at/cm^3) = f(x(cm))$ representing the diffusion profiles of oxygen in Zr_α, in which x = the distance measured from the metal-oxide interface, does not represent the variation in the elementary jump length of a diffusing oxygen atom with the oxygen contents. In order to represent this variation, the $\chi = f(N)$ function is considered (χ = the number of oxygen atoms/number of Zr atoms) and N = the number of elementary jumps corresponding to the distance x(cm). The relative variations of the diffusion coefficient $D(cm^2/s)$ with the oxygen concentration were obtained. The following values were obtained for the diffusion coefficient, Do, corresponding to an oxygen content of zero at 700, 750, 810, and 845°C: $1.3 \cdot 10^{-11}$, $3.9 \cdot 10^{-11}$, $1.3 \cdot 10^{-10}$, and $2.7 \cdot 10^{-10}$ cm^2/s. (France)

Radiation Effects

Refer also to abstracts 58757, 60399–60401, 60406, 60412, 60517, 60564, and 60569.

59307 (AERE-R-6320) DISPLACEMENT DAMAGE IN NIOBIUM FROM FAST NEUTRON IRRADIATION. Blow, S. (Atomic Energy Research Establishment, Harwell (England)). Aug 1970. 21p. Dep. NTIS (U. S. Sales Only).

An analysis of the displacement damage produced in niobium, which has potential use as the first wall material of a fusion reactor, is presented. Lindhard's formalism is used together with cross-sections for elastic, inelastic, and (n,2n) scattering taken from the U. K. nuclear data file on niobium. Data sets were generated, which described damage energy created at various neutron incident energies. A result of this analysis was that: the ratio of damage density (i.e., mean damage energy x cross section) at 14 MeV to 1 MeV is 3.46 for niobium. The damage energy data sets were integrated over three different neutron spectra in order to compare the total effects. The spectra were taken from: the first wall of model fusion reactor, with a total flux of 2.8×10^{15} n cm^{-2} sec^{-1}, the core center of the Dounreay Fast Reactor (D.F.R.), total flux 2.5×10^{15} n cm^{-2} sec^{-1}, and the inner breeder region of the D.F.R., flux 1.5×10^{15} n cm^{-2} sec^{-1}. Analysis showed the number of atomic displacements per atom per year. It was concluded that four months' irradiation in the D.F.R. inner breeder will be roughly equivalent to 1 month's exposure in the first wall of a fusion reactor. (auth)

59308 (BARC-578) RADIATION HARDENING OF ZIRCONIUM. Hammad, A. M.; Sharma, B. D.; Rodriguez, P. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 29p. Dep. NTIS (U. S. Sales Only).

The effects of neutron irradiation on the mechanical properties of sponge zirconium are described. The tensile specimens were irradiated in Apsara Swimming Pool Reactor at 50°C to integrated neutron flux of 9.5×10^{18} nvt. The effect of neutron dose on increase in 0.2% yield stress, the recovery of radiation damage and thermally activated deformation of irradiated zirconium were the main features investigated. Thin film electron microscopy of irradiated zirconium was also carried out in order to correlate the defect structures with the mechanical properties. (auth)

59309 (BNWL-tr-77) IRRADIATION CREEP OF TWO SLIGHTLY ALLOYED URANIUM MATERIALS. Englander, M.; de Montpreville, C. Thomas ([Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires]). Translated by E. R. Appleby (Battelle-Northwest, Richland, Wash.), from report DM-T/RT-108. 22p. (CONF-670664-1). Dep. NTIS.

From 11th symposium on metallurgy (creep); Saclay, France (22 Jun 1967).

Creep specimens of alloys of natural uranium (U–1.1 wt.% Mo and U–800 ppM–80 ppM Cr–350 ppM Fe–100 ppM Si) were irradiated at certain characteristic temperatures, under slight tensile stress, in a device especially developed for the EL-3 reactor. After several hundred hours of irradiation, elongation of the specimens was compared to that of control specimens, placed out-of-reactor under conditions of creep as close as possible to those of the in-reactor tests. Measurements made have shown that the dimensional instability specifically related to the test conditions, either by initial texture or by structural evolution, has made a relatively important quantitative contribution to the total deformation rate under external loading. Taking this contribution into account, deformation rate under irradiation, at all of the temperatures studied, remained much higher than that without irradiation, the difference being accentuated as an inverse function of the temperature. (auth)

59310 (RD/B/N-2354) INTERACTION OF DISLOCATION LOOPS AND γ' PRECIPITATE IN NICKEL BASED ALLOYS. Williams, K. R.; Fisher, S. B. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jun 1972. 26p. Dep. NTIS (U. S. Sales Only).

The interaction between radioinduced dislocation loops and coherent precipitates was studied directly in nickel-base alloys containing ordered γ' precipitate with both positive and negative misfit. The loop particle interactions obey the isotropic elasticity theory developed by Eshelby (1957). Subsequent loop nucleation and growth is controlled by the presence of γ' precipitate. Due to the interaction, relatively low radioinduced dislocation densities are developed. At large non-coherent γ' particles ($\approx 0.6\mu$ dia) loop nucleation is controlled by the presence of interfacial dislocations. Also, vacancies precipitate as two dimensional loops behind climbing interfacial dislocations. It was concluded that the following mechanisms contribute to make γ' hardened alloys resistant to swelling: the action of coherency strains in reducing the density of climbing dislocations; the influence of the precipitate on the climb efficiency of the Frank dislocations by pinning the dislocation line and making the dislocation Orowan loop around obstacles, which introduces a force opposing climb arising from the dislocation line tension, and also by reducing absorption of interstitials by the climbing dislocation, which will be especially significant at high volume fractions. (auth)

59311 RADIATION AND ANNEAL HARDENING IN VANADIUM. Shiraishi, K.; Fukaya, K.; Katano, Y. (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Mater.; 44: No. 2, 228-38(Aug 1972).

The tensile properties at room temperature in vanadium irradiated to a fast neutron fluence of 8.2×10^{19} n/cm^2 at about 200°C were investigated in terms of changes in microstructure with the irradiation and subsequent heat treatment. Dislocation channeling was observed in the deformed specimens that were irradiated and subsequently annealed for 1 hr at temperatures of 400°C or below; the specimens contained small dislocation loops of the order of $10^{16}/cm^3$ in density. Hardening due to postirradiation annealing was found to occur in the temperature range of 180 to 600°C. The radiation anneal hardening was considered to arise from interstitial impurity clusters. The radioinduced hardening recovered almost completely with a 1 h anneal at 700°C. (auth)

59312 EFFECT OF NEUTRON IRRADIATION ON THE E.M.F. STABILITY OF A Pt-5 PERCENT Mo/Pt-0.1 PERCENT Mo THERMOCOUPLE. Gray, W. J. (Battelle-Northwest, Richland, Washington). Contract AT(45-1)-1830. J. Nucl. Mater.; 44: No. 2, 239-40(Aug 1972).

The irradiation and subsequent calibration of a Pt–5% Mo/Pt–0.1% Mo thermocouple are described. The results showed that emf outputs of both irradiated and unirradiated thermocouples were slightly low. The irradiated and unirradiated thermocouples agreed, however, to within 0.5% of one another over the entire range from room temperature to 1500°C. However, for practical purposes there was no measurable effect of irradiation on the Pt/Mo thermocouple. It was concluded that the absence of any decalibration makes the x Pt/Mo thermocouple a good candidate for use in a nuclear environment up to 1500°C. (P.C.H.)

59313 DOSE AND STRAIN DEPENDENCE OF THE ACTIVATION VOLUME OF VANADIUM IRRADIATED WITH FAST NEU-

TRONS. Bocek, M. (Kernforschungszentrum, Karlsruhe, Ger.); Elen, J. D. J. Nucl. Mater.; 44: No. 2, 194-206(Aug 1972).

The activation volume ΔV of vanadium was influenced by neutron irradiation. The change in ΔV was dependent on the oxygen content as well as on the irradiation temperature. The increase of ΔV after irradiation is explained by scavenging. At the higher irradiation temperature the formation of large, planar imperfections at the lowest fluences was observed. It was assumed that these imperfections are due to radioinduced precipitation of interstitial impurities. (auth)

59314 RATE THEORY OF SWELLING DUE TO VOID GROWTH IN IRRADIATED METALS. Brailsford, A. D.; Bullough, R. (United Kingdom Atomic Energy Authority, Harwell, Eng.). J. Nucl. Mater.; 44: No. 2, 121-35(Aug 1972).

Rate theory equations for the spatially averaged interstitial and vacancy concentrations in irradiated materials containing sessile dislocation loops, deformation dislocations, voids and coherent or incoherent precipitates are derived. The physical role of each of these defect sinks is elucidated and appropriate strengths for each type (for interstitials and vacancies) are evaluated. Solution of the rate equations leads to a general expression for the volume-swelling rate. Under certain well controlled approximations this may be integrated to yield the following approximate formula, deemed appropriate for design purposes, for the percentage volume-swelling, $\Delta V/V\%$: $(\Delta V/V)\% = SF(\eta)K(t - t_0)$, where Kt is the dose in displacements per atom, $\eta = 400 \exp[-(E_m^v/k)(1/T_s - 1/T)]$ and $F(\eta) = (2/\eta)\ [\{1 + \eta\}^{1/2} - 1 - \frac{1}{2}\eta \exp\{-(Q/k)(1/T - 1/T_f)\}]$. E_m^v and Q are the activation energies for vacancy motion and self-diffusion by the vacancy mechanism respectively, for which recommended values are given. T_s and T_f are respectively the start and finish temperatures for the void-swelling regime and S a scale parameter to be adjusted to fit the experimental data. This swelling relation is only intended to apply at doses below that for which the swelling shows saturation as a function of dose. A general discussion is also given on the effects on the void-swelling of cold work, precipitate or void dispersion, and temperature. Analytical expressions are presented for the onset and termination temperatures of the swelling, for the peak swelling temperature and its possible shift with cold work, and for the maximum volume-swelling due to voidage. (auth)

59315 EFFECT OF NEUTRON IRRADIATION ON THE TENSILE PROPERTIES OF ZIRCALOY-2 AND ZIRCALOY-4. Higgy, H. R.; Hammad, F. H. (Atomic Energy Establishment, Cairo). J. Nucl. Mater.; 44: No. 2, 215-27(Aug 1972).

The effects of fast-neutron damage on the room-temperature tensile properties of Zircaloy-2 and Zircaloy-4 irradiated at low temperature (<100°C) up to a fluence of 1.43×10^{20} n/cm^2 (>1 MeV) and at elevated temperature (320 to 360°C) up to 1.53×10^{21} n/cm^2 (>1 MeV) were investigated. The irradiation conditions at elevated temperature simulated those of fuel elements. The behavior of irradiation-hardening of Zircaloy-2 was similar to that of Zircaloy-4. Considerable irradiation-hardening and loss of ductility were observed. The rate of hardening for low-temperature irradiation was higher than that for elevated-temperature irradiation. Irradiation-induced changes in yield stress, $\Delta\sigma_y$, showed saturation at a fluence of 4×10^{19} n/cm^2 (>1 MeV) for Zircaloy-2 and 5×10^{19} n/cm^2 (>1 MeV) for Zircaloy-4 for low temperature, while no saturation was observed after elevated-temperature irradiation up to a fluence of 1.53×10^{21} n/cm^2 (>1 MeV). Low-temperature irradiation showed $\Delta\sigma_y \propto (\phi t)^{1/2}$ below saturation while elevated-temperature irradiation showed $\Delta\sigma_y \propto (\phi t)^{0.1}$. The amount of irradiation-hardening decreased in Zircaloy-4 as the pre-irradiation yield stress was increased either by increasing the amount of cold work or decreasing the grain size. The results are discussed in terms of recent results in electron microscopy of irradiated materials. (auth)

59316 STRUCTURAL CHANGES IN AGE-HARDENABLE ALUMINIUM ALLOYS INDUCED BY LOW TEMPERATURE NEUTRON IRRADIATION. Liu, K. S. (Kyoto Univ.); Kawano, O.; Murakami, Y.; Yoshida, H. Radiat. Eff.; 15: No. 1-2, 37-49(Jul 1972).

In order to investigate the structural changes in alloys with different size and structure of small spherical Guinier–Preston (GP) zones and intermediate precipitates, measurements of x-ray small angle scattering were carried out at liquid nitrogen temperature for Al–4.4 at. % Zn, Al–1.0 at. % Ag, Al–5.0 at. % Zn–5.0 at. % Ag and Al–2.8 at. % Zn–1.4 at. % Mg alloys. Through the measurement of the scattering intensities before and after irradiation with doses of 3.2×10^{15} and 1.5×10^{16} neutrons cm^{-2} below 20°K, the changes in size, volume fraction, and size distribution were clearly detected. The Guinier radius decreased with irradiation for all of the specimens. The Porod radius of GP zones in the binary alloys also decreased, except the Al–Zn alloy containing small GP zones with short spacing. The integrated intensity, which is proportional to the volume fraction, slightly decreased for the binary alloys, and increased for the ternary alloys. The size distribution after irradiation became wider for the specimens containing GP zones or precipitates with short spacing, but narrower for the ones with long spacing of GP zones and low concentration of solutes in matrix. This behavior is explained by the mechanism of breaking of small spherical GP zones and precipitates by collision cascades and displacement spikes during low-temperature irradiation. (auth)

59317 VOIDS IN IRRADIATED METALS. 2. Norris, D. I. R. (Central Electricity Generating Board, Berkeley, Eng.). Radiat. Eff.; 15: No. 1-2, 1-22(Jul 1972).

Any type of irradiation that displaces atoms can produce voids in non-fissile metals and alloys, consequent swelling and mechanical property effects becoming important in fast reactor design and operation. The basic reason for void formation is preferential absorption of interstitials at dislocations. Void growth depends on competition between alternative sinks for diffusing vacancies and interstitials. Irradiation and materials variables affect void formation through both the point defect behavior and dislocation behavior. Void ordering and annealing effects are also discussed. (auth)

59318 IRRADIATION CREEP DUE TO A STRESS GRADIENT. Mosedale, D. (Experimental Reactor Establishment, Dounreay, Eng.). Radiat. Eff.; 14: No. 3-4, 281-2(Jun 1972).

Nabarro's proposal (F. R. N. Nabarro, Report of a Conference on Strength of Solids, The Physical Society, London, 1948, p.75) that a gradient of hydrostatic stress would cause vacancies and interstitials, produced by neutron bombardment, to move so as to reduce the pressure difference and that the resulting flow of matter to grain boundaries would be observed as creep is supported by a mathematical treatment. (UK)

59319 RADIATION DAMAGE IN ANNEALED TYPE 304 STAINLESS STEEL. Bloom, E. E.; Stiegler, J. O.; McHargue, C. J. (Oak Ridge National Lab., Tenn.). Radiat. Eff.; 14: No. 3-4, 231-43(Jun 1972).

The defect structures in irradiated Type 304 stainless steel were characterized by transmission electron microscopy for irradiation temperatures between 370 and 840°C and for fluences ranging from 10^{18} to 10^{23} neutrons/cm^2 (>0.1 MeV). Below about 550°C the interstitial atoms produced by the irradiation precipitated as Frank sessile loops, which decreased in concentration and increased in size with increasing irradiation temperature. About 550°C the loops unfaulted and evidently glided and interacted to form a loosely organized dislocation network, which became coarser with increasing irradiation temperature. The vacancies precipitated as voids, which also decreased in concentration and increased in size with increasing temperature. The damage appeared to be first visible at a threshold fluence that increased with increasing radiation temperature. At high fluences, void concentrations approached a saturation concentration that decreased with increasing irradiation temperature. Voids were often not homogeneously distributed but were preferentially associated with dislocations and precipitate particles. The void concentrations and size distributions were not strongly dependent on the fast neutron flux, at least over range encountered in fast reactors. These observations are discussed in terms of proposed mechanisms for void formation. It was concluded that most of the voids are probably nucleated on complexes of vacancies and helium atoms resulting from (n, α) transmutations. (auth)

59320 RECOVERY STUDY IN PURE AND COPPER ALLOYED ALUMINIUM AFTER NEUTRON IRRADIATION AT LIQUID–NITROGEN TEMPERATURE. Papathanassopoulos, K.; Andronikos, P. (Democritus Nuclear Research Center, Athens). Radiat. Eff.; 14: No. 3-4, 215-23(Jun 1972).

Samples of pure aluminum and aluminum alloyed with copper (0.025 to 0.5 at. %) were irradiated with neutrons at 78°K. Isochronal annealing was carried out in two series of samples with different heating rates (0.5 and 2.5°K/min) from 78 to 280°K. The annealing of stage III occurred by a second-order process with an activation energy E = 0.58 ± 0.05 eV, for both pure and copper dilute aluminum alloys. From the experimental results, the recovery of stage III can be explained in terms of a model where single vacancies migrate. The magnitude of stage II region sensitively depends on the type of solute atoms in the lattice. The Al–Cu alloys showed almost no recovery until stage III. (auth)

59321 VAPORIZATION OF SILVER–5 AT. PERCENT INDIUM ALLOY DURING β IRRADIATION OF ITS SURFACE. Sklyarenko, I. Ya.; Priselkov, Yu. A.; Zimakov, I. E.; Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Moscow). Izv. Akad. Nauk SSSR; Ser. Khim.; No. 4, 783-6(Apr 1972). (In Russian).

The vaporization of the alloy Ag–5 at.% In was studied at 1,300 to 1,150°K in a vacuum while the alloy surface was bombarded with β particles from a ^{90}Sr$-^{90}$Y source. Vaporization in the absence of radiation was of an unsteady nature and was characterized by considerable dispersion in its measurement. Irradiation of the alloy surface with β particles rapidly established a steady-state condition with respect to vaporization of both components of the alloy. (K.S.W.)

59322 SOME FEATURES OF THE BEHAVIOUR OF STRUCTURAL MATERIALS IN A POSSIBLE FUSION REACTOR BLANKET. Blow, S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 4, 371-6 (Oct 1972).

An introduction to the size and form of a typical fusion reactor blanket is given. Neutron spectra are then derived in the various blanket regions, and neutron flux values are normalized to an economic heat flux through the first wall of 13 MW/m^2. The effect of the neutron flux on structural materials is investigated in respect of inert gas bubble formation, displacement damage, transmutation, induced activity, and decay power. The materials studied are niobium, molybdenum, and Nimonic alloy PE16. Molybdenum is shown to be superior in most respects to the other refractory metal, niobium. The nickel-based alloy PE16 has a number of attractive features including cheapness and resistance to void formation. It also possesses the overriding drawback of being incompatible with liquid lithium. (auth)

59323 RESEARCH ON METALLIC FUELS. Schumar, J. F. (Argonne National Lab., Ill.). pp 187-200 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

A review is presented on some of the recent results of swelling studies in U alloys, studies of EBR-II uranium fission fuel, and studies of a uranium base plutonium alloy for fast breeder reactors. Special attention was given to understanding the mechanisms of swelling, relating those mechanisms to the metallurgical properties and the fission event, and altering the metallurgical properties by alloying and heat treatment. (P.C.H.)

59324 MEASUREMENT OF IRRADIATION INDUCED SWELLING BY A SEMI-AUTOMATIC LENGTH MEASURING TECHNIQUE. Watkin, J. S. (United Kingdom Atomic Energy Authority, Springfields, Eng.); Ervine, R. W.; Cocks, H. J. Brit. Nucl. Energy Soc.; 11: No. 4, 367-70(Oct 1972).

A technique is described for obtaining void swelling data after fast reactor irradiation on a wide range of steels, nickel alloys, and refractory metals. A semi-automatic machine capable of measuring the length of specimens 10 mm long, after irradiating to an accuracy of ±0.5 μm at a rate of 20 per day, is used. This is described together with the ancillary equipment used to dismantle the specimens from irradiation containers to identify them and to reload them into containers for further irradiation. (UK)

Other Materials

Refer also to abstracts 58600, 58955, 59179, 59186, 59205, 59240, 60396, 60424, and 60516.

59325 (BNL-16989) THERMAL POLYMERIZATION OF RADIATION CONDITIONED MONOMERS FOR THE PRODUCTION OF CONCRETE-POLYMER MATERIALS. Steinberg, M.; Fontana, J.; Colombo, P. (Brookhaven National Lab., Upton, N. Y.). Feb 1972. 18p. Dep. NTIS.

For the purpose of reducing the hazard of handling excess monomer containing a chemical initiator in the production of polymer impregnated concrete and to reduce the radiation dose requirements for the polymerization of monomer in concrete, a system is proposed to remove the inhibitor in the bulk monomer prior to impregnation by gamma radiation reactions. The radiation conditioned monomer is then allowed to impregnate the concrete after which the monomer is thermally polymerized in-situ with no further addition of chemical catalyst. Data are presented for the removal of inhibitor by ^{60}Co gamma radiation from the bulk monomers, methyl methacrylate (MMA), styrene, t-butyl styrene and trimethylolpropane trimethacrylate (TMPTMA). The subsequent thermal polymerization of the radiation conditioned monomers is indicated. The in-situ polymerization of radiation conditioned styrene-TMPTMA comonomers and t-butylstyrene has been shown and compressive strength of the polymer-concretes has been measured. In the case of MMA further work is needed to determine the reason for incomplete polymerization of the monomer in the center part of the concrete. A process based on this system is discussed. (auth)

59326 (JUL-868-RW) ANISOTROPY VARIATION OF CRYSTALLOGRAPHIC ORIENTATION IN PYROCARBON COATINGS OF FUEL PARTICLES BY ANNEALING AND NEUTRON IRRADIATION. Koizlik, Karl (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Jun 1972. 102p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

Optical measurements to determine the orientation anisotropy directly at the pyrocarbon coatings of fuel particles are described. A correlation was detected between anisotropy factors by means of optical and x-ray measurements. The optical measurement permits detection of the orientation anisotropy and its variation by annealing and neutron irradiation of the particle coatings. Also, dependencies were found between the material properties of pyrocarbon, annealing or irradiation data, and the anisotropy increase. To explain the measured results, a model is discussed and compared with those suggested in the literature. (auth)

59327 (ORNL-tr-2633) STRUCTURE OF PROPYLENE-PYROCARBON COATINGS OF COATED FUEL PARTICLES AND ITS MODIFICATION BY ANNEALING. Gyarmati, E.; Koizlik, K.; Gupta, A. K. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Translated for Oak Ridge National Lab., Tenn., from report JUL-795-RW. 22p. Dep. NTIS.

For an irradiation experiment (U,Th)O$_2$-kernels were coated with pyrocarbon of different density and orientation anisotropy. The deposition of pyrocarbon was carried out with propylene, C_3H_6. In order to get information about the alteration of the structure of the coatings before the irradiation, the particles were heat treated. As a consequence of the heat treatment the orientation anisotropy of pyrocarbon increases. The rapid growth of the orientation anisotropy can be explained by the generation of strong tensions having long ranges in the pyrocarbon coating. There exists a density range around approximately 1.7 g/cm^3 in which there appear only very small anisotropy-increases by heat treatment below 2000°C. The increase of the anisotropy is higher in case the anisotropy of the starting material increases and its apparent crystallite size decreases. (auth)

59328 SPECIFICS OF SATURATION OF POROUS GRAPHITE BASES WITH MELTED ZIRCONIUM. Yelyutin, V. P.; Kostikov, V. I.; Dergunova, V. S.; (and others). Tsvetn. Metal.; No. 1, 46-50(1971). (In Russian).

Regularities involved in the process of capillary saturation of various porous graphite materials with liquid zirconium were studied. An attempt was made to determine experimentally the apparent activation energy of the process and to determine the influence of individual factors on various stages of the process. The experiments were performed in a specially designed high-temperature installation under a vacuum of 2×10^{-2} mm Hg. The experiments showed that the melt flows energetically over the outer surface of specimens, thus producing elevated capillary rise values on specimens less than 60 mm in diameter due to additional penetration of the melt through side surface pores. Penetration of porous graphite materials with liquid zirconium occurs by flow of the zirconium along poor walls. The time dependence of movement of the saturation front under isothermal conditions forms a quadrative parabola. The apparent activation of the process of saturation was calculated for type PROG-2004 and PG-50 graphites. (JPRS)

59329 RADIATION EFFECTS ON STRENGTHS OF BORON-EPOXY COMPOSITES IN VARIOUS ENVIRONMENTS. Bullock, R. E. (General Dynamics, Fort Worth, Tex.). J. Nucl. Mater.; 44: No. 2, 175-84(Aug 1972).

Light weight, high strength boron-epoxy composites were irradiated in a nuclear reactor and then mechanically tested for strength. These boron-epoxy laminates, made by reinforcing an epoxy matrix with 15 plies of unidirectional boron filaments, were irradiated and tested under three different combinations of temperature which could occur in a nuclear-powered spacecraft using a cryogenic propellant. Specimens of group 1 were irradiated in air or water at ambient temperatures below 80°C and were tested at room temperature, as were specimens of group 2 which were irradiated in liquid hydrogen at −253°C. Specimens of group 3 were irradiated and tested in liquid nitrogen at −196°C without an intermediate warmup. Mechanical strengths of all specimen groups were degraded primarily by thermal neutrons. For equivalent thermal-neutron fluences, flexural strengths in the longitudinal direction (parallel to boron filaments) were best for specimens of group 1, next best for those of group 2, and poorest for those of group 3. This order of degradation seemed to be dictated by the more radiation-sensitive interlaminar shear strength, which measures epoxy-to-filament bonding. The order of damage above was reversed for transverse flexural strengths. (auth)

59330 DIMENSIONAL CHANGES INDUCED IN POORLY CRYSTALLINE ISOTROPIC CARBONS BY IRRADIATION. Kaae, J. L.; Stevens, D. W.; Bokros, J. C. (Gulf General Atomic Inc., San Diego, Calif.). Carbon; 10: No. 5, 561-70(Oct 1972).

The density and dimensional changes induced by fast-neutron irradiation of isotropic pyrolytic carbons deposited below 1500°C were investigated. Irradiation temperatures ranged from 600°C and fast-neutron fluences extended to 8×10^{21} n/cm^2. It was found that, in contrast to the more crystalline carbons deposited at higher temperatures, these carbons do not increase in volume at high fast-neutron fluences and that the lineal dimensional changes do not increase with temperature above 1000°C. At temperatures below 1000°C, the dimensional changes are not greatly different from those of the more crystalline carbons. (auth)

59331 FRACTURE SURFACE OF SILICONATED PYROLYTIC GRAPHITE. Yajima, S. (Tohoku Univ., Ibaraki, Japan); Hirai, T.; Hayase, T. J. Mater. Sci.; 7: No. 9, 1095-7(Sep 1972).

Pyrolytic graphite and siliconated pyrolytic graphite were prepared at various deposition temperatures. The microscopic and x-ray structures were studied in relation to fracture behavior. The fracture surfaces were examined on a scanning microscope. The results suggest that fracture behavior is closely related to the x-ray structures but not to the microscopic structures. (UK)

59332 EFFECTS OF FAST-NEUTRON IRRADIATION ON ELASTIC MODULI OF CARBON FIBERS. Bullock, R. E. (General Dynamics, Fort Worth, Tex.). Radiat. Eff.; 14: No. 3-4, 263-5(Jun 1972).

Two types of carbon fibers (high tensile and high modulus) were irradiated with fast neutrons in air or liquid nitrogen environments and their elastic properties measured before and after irradiation. It was found that there was a significant improvement in the elastic properties of the high tensile fibers after irradiation and that the potential exists for an even greater improvement by means of higher exposures. (UK)

59333 RADIATION POLYMERIZED COMPOSITES BASED ON WOOD. NEW MATERIALS FOR USE IN CORROSIVE ENVIRONMENTS. Hills, P. R. (Atomic Energy Research Establishment, Harwell, Eng.). Composites; 3: No. 5, 211-15(Sep 1972).

A polymer—wood composite, Curifax, has recently been used for the construction of a corrosion-resistant walkway system in a new electrolytic chlorine plant. The preparation and uses of these polymer wood composites are described. (auth)

59334 PROCESS FOR COATING ARTICLES. Ravve, Abraham; Khamis, Joseph Thalia (to Continental Can Co., Inc.). British Patent 1,280,063. 5 Jul 1972. Filed 27 May 1970.

A process for coating articles is described that comprises the steps of applying a thin film of an aqueous colloidal dispersion of a co-polymer consisting of an α-olefin having the general formula RCH = CH$_2$, where R is H or an alkyl group having 1 to 8 C atoms, and are α, β-ethylenically unsaturated carboxylic acid having 3 to 8 C atoms, or an acid ester or anhydride of such a carboxylic acid. The aqueous dispersion also contains a water-soluble inorganic salt of a divalent or trivalent metal cation. The film coated surface is heated to remove the aqueous dispersant and is then electron irradiated to a dosage of 0.1 to 10 MR to effect cross-linking. The α-olefin may be ethylene and the α,β-ethylenically unsaturated carboxylic acid may be acrylic acid. The polyvalent metal may be Zn in the form of ZnCO$_3$. The process is rapid and gives hard and adherent polymeric coatings, particularly on metal substrates. (UK)

59335 STRENGTHENING OF CARBON FIBRES BY FAST NEUTRON IRRADIATION. Jones, B. F.; Peggs, I. D. (Atomic Energy of Canada Ltd., Pinawa). Nature (London); 239: No. 5367, 95-6(8 Sep 1972).

In order to assess the effect of fast neutron irradiation on the structure and mechanical properties of a polyacrylonitrile (PAN)-based fiber, samples were irradiated in the WR1 organic-cooled reactor at 400 to 700°C. Mechanical tests were made at room temperature before and after irradiation using a microtensile test machine, and fiber structure was studied by x-ray diffraction. Fiber densities were measured by a gradient technique. In the unirradiated condition the fibers showed an average fracture strength of 2.86 GNm^{-2} and a Young's modulus of 215 GNm^{-2}. Irradiation at about 420°C to a total neutron dose of 4×10^{17} n cm^{-2} produced an increase of 12% in fracture strength and 7% in Young's modulus. Such changes may be attributed to pinning of dislocations by irradiation-induced interstitial atoms. Irradiation at about 500°C to a similar dose, however, produced decreases in both properties of 22% and 11%, respectively, attributed to irradiation-induced crack or void formation. Irradiation at still higher temperatures at larger doses again produced increases. The largest change in properties recorded occurred after irradiation at about 550°C to 6.6×10^{20} n cm^{-2}, the fracture strength being increased by ~40% to 4.04 GNm^{-2} and the modulus by ~12% to 248 GNm^{-2}. Strain to fracture increased from 1.2% in the unirradiated fiber to 1.6% after irradiation. Changes in fiber density and apparent crystallite size are shown graphically. (UK)

59336 EVOLUTION IN THE MECHANICAL AND PHYSICOCHEMICAL PROPERTIES OF IRRADIATED MATERIALS FOR THE MANUFACTURE OF RADIOSTERILIZED MEDICO-SURGICAL SUPPLIES. Icre, P. (Societe de Recherches Techniques et Industrielles, Paris); Blanchard, J. C. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 93, 53-69(Jan 1972). (In French).

From Meeting on sterilization techniques of medical and surgical instruments by ionizing radiations; Lyon, France (18 Nov 1971). See CONF-711144.

Solid polymers were irradiated. The effects of atmospheric oxygen, the form of the products irradiated, and the nature of the irradiation on the modifications induced (cross-linking or degradation), and the physicochemical and mechanical properties were studied. The principal results for the following polymers are given: polyethylene, polypropylene, polystyrene, polyamide, silicones, PVC, and latex. (France)

59337 REFRACTORY COMPOUNDS. Stephen, Robert Charles; Lee, Stephen Arthur; Cardy, Charles Frederick; Sampson, Keith George (to Laporte Industries Ltd.). British Patent 1,280,506. 5 Jul 1972. Filed 29 Aug 1969.

A process is described for the preparation of SiC whiskers, comprising contacting a source of halogens with a Si compound and reacting the gaseous products with a gaseous carbon compound. The halogen source may be halogens themselves, other than I$_2$, or halogen compounds that are gaseous at the selected reaction temperature, and the Si compound may be solid phase nitride, phosphide, boride, or carbide. The carbon compound may be CO or hydrocarbons. The reaction temperature is preferably in the range 1450 to 1750°C, and the pressure at least 100 mm Hg. The SiC whiskers are formed in a condensation zone. Chlorine is a suitable halogen to employ and suitable halogen compounds are hydrogen halides, silicon halides, and carbon halides. The halogen source may be diluted with an inert gas or hydrogen, and H$_2$O$_3$ may usefully be present in the reaction zone. The condensation zone may be at least 50°C below the temperature of the reaction zone, and the gaseous source of C may be introduced into the former zone. (UK)

59338 REFRACTORY COMPOUNDS. Stephen, Robert Charles; Lee, Stephen Arthur; Cardy, Charles Frederick; Sampson, Keith George (to Laporte Industries Ltd.). British Patent 1,280,648. 5 Jul 1972. Filed 29 Aug 1969.

A process is described for the preparation of SiC whiskers comprising contacting a source of F$_2$ with elementary Si or a Si alloy and reacting the gaseous products so formed with a gaseous C compound, thereby forming SiC whiskers in a condensation zone. The reaction temperature is >1050° and preferably in the range 1450 to 1650°C, and the pressure at least 100 nm Hg. The Si alloy should contain at least 50% Si by weight. The F$_2$ source may be HF or SiF$_4$, and the C compound may be CO or hydrocarbons. The F$_2$ source may be diluted with an inert gas or H$_2$. Al$_2$O$_3$ may be present in the reaction zone with advantage. The temperature of the condensation zone should be at least 50°C lower than that of the reaction zone, and the C source may be introduced into the former zone. (UK)

59339 REFRACTORY COMPOUNDS. Lee, Stephen Arthur; Cardy, Charles Frederick; Sampson, Keith George (to Laporte Industries Ltd.). British Patent 1,280,649. 5 Jul 1972. Filed 29 Aug 1969.

A process is described for the preparation of SiC comprising reacting at a temperature in the range 1350 to 1800°C, a mixture of SiO$_2$, elementary C, a source of S, hydrogen, and a gaseous C compound, whereby SiC is formed in a condensation zone. The C source may be a hydrocarbon or CO or a mercaptan or organic sulphide or H$_2$S. The reaction temperature is preferably in the range 1450 to 1650°C. An inert gas diluent may be employed and the temperature of the condensation zone should be at least 50°C below that of the reaction zone. (UK)

59340 HIGH TEMPERATURE CREEP OF A POCO GRAPHITE. Zukas, E. G.; Green, W. V. (Los Alamos Scientific Lab., N. Mex.). Carbon; 10: No. 5, 519-24(Oct 1972).

The creep behavior of POCO grade HPD-1 graphite was studied from 2200 to 2500°C in the as-received condition as well as after annealing at either 2750 or 2900°C. The apparent activation energy for creep, the stress dependence, the time dependence, creep curve shape, and recovery behavior were similar to those for the typical commercial polycrystalline graphites. However, there were several important differences. Creep strains to fracture were large, generally exceeding 30% and they can exceed 70%. There was also a reduction in cross-sectional area, by as much as 20%, during high temperature deformation. Fracture stresses at high temperatures were high, sometimes reaching , 18 to 20,000 psi, but the creep rates were relatively rapid at stresses of the order of ⅓ of the fracture stress. These differences were attributed to the small pore size of the POCO graphite and the uniform distribution of these pores. (auth)

59341 DIMENSIONAL CHANGES AND CREEP OF POORLY CRYSTALLINE ISOTROPIC CARBONS AND CARBON–SILICON ALLOYS DURING IRRADIATION. Kaae, J. L.; Bokros, J. C.; Stevens, D. W. (Gulf General Atomic Inc., San Diego, Calif.). Carbon; 10: No. 5, 571-85(Oct 1972).

The dimensional changes and creep of poorly crystalline isotropic pyrolytic carbons ($L_c < 40$ Å) and carbon–silicon alloys due to fast-neutron irradiation were studied. The irradiation temperatures were 840, 1000, 1330, and 1430°C, and the fast-neutron fluences extended to 8.7×10^{21} n/cm^2. The densifications of the pure carbons decreased with increasing preirradiation density, and at the higher temperatures, the high-density specimens expanded slightly. Silicon alloying decreased the dimensional changes. Creep was studied by restraining the carbons and alloys on graphite discs and sapphire balls. Assuming that the restraint did not affect the dimensional changes, it was possible to calculate a creep constant from the behavior of the spherically restrained specimens. (auth)

59342 EFFECT OF CHLORINE ON THE DEPOSITION OF PYROLYTIC CARBON. Kobayashi, F.; Ikawa, K.; Iwamoto, K. (Japan Atomic Energy Research Inst., Tokai). Carbon; 10: No. 5, 647-8(Oct 1972).

The effects of minor additions of chlorine, as CCl_4, on the decomposition temperature of propane/argon gas mixtures, for the deposition of pyrolytic carbon on nuclear fuel particles, were investigated. Chlorine additions equal to 7% of the propane increased the deposition rate at a given temperature. Density and crystallite size were relatively unaffected. (UK)

59343 BINARY SYSTEMS ThF_4–$MgCl_2$ AND ThF_4–$CaCl_2$. Desyatnik, V. N.; Kurbatov, N. N.; Raspopin, S. P.; Trifonov, I. I. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb Zaved., Tsvet. Met.; No. 2, 78-9(1972). (In Russian).

Melting point diagrams were constructed for the two binary systems of ThF_4 with the chlorides of either Mg or Ca. Two compounds ($3MgCl_2 \cdot ThF_4$ melting at 680°C, and $MgCl_2 \cdot ThF_4$ melting congruently at 920°C) and two eutectics melting at 575 and 850°C were observed for the first system. In the second system only one compound ($CaCl_2 \cdot 7ThF_4$) formed, melting incongruently at 680°C, and only one eutectic melting at 520°C was observed. (K.S.W.)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

59344 (BNL–16990) ENRICHMENT MEASUREMENT IN LOW ENRICHED ^{235}U FUEL PELLETS. Gundersen, Gordon; Cohen, Ira; Zucker, Martin (Brookhaven National Lab., Upton, N. Y.). 1972. 17p. (CONF-720529–5). Dep. NTIS.

From 13th annual meeting of the Institute of Nuclear Materials Management; Boston, MA. (31 May 1972).

A multi-channel analyzer and NaI-photomultiplier tube were used to measure the ^{235}U enrichment in low enriched UO_2 pellets. A selection of pellets ranging from 0.85% to 16% in enrichment and of diverse origins was found to yield an accurately linear relation between a properly defined counting rate and the percent ^{235}U enrichment. It was found necessary to perform the background subtraction carefully in order for the resulting linear plot to pass through the origin. A simple technique for making pellet measurements was developed based on this observation which is sufficiently accurate to separate the usual neighboring values of enrichment. Field applications and experiences with this technique for low enriched fuel pellet measurements are described. (auth)

59345 (BNWL-SA–4251) USE OF ISOTOPIC CORRELATIONS IN VERIFICATION (SAFEGUARDS APPLICATION). Schneider, R. A.; Stewart, K. B.; Christensen, D. E. (Battelle Pacific Northwest Labs., Richland, Wash.). 10 Feb 1972. Contract ACDA/WEC-216. 63p. (CONF-720455–7). Dep. NTIS.

From Meeting on the use of isotopic composition data in safeguards; Vienna, Austria (10 Apr 1972).

Work done to date to evaluate the potential safeguards value of heavy element isotopic correlations is reviewed. Two applications which have potential value in IAEA verification activities, i.e., the use of isotopic correlations in supporting the Pu/U ratio method of verifying the Pu input to reprocessing and the use of isotopic correlations and associated dissolver solution data in confirming safeguards information about spent fuels, which is stated prior to receipt at the reprocessing plant, are considered in detail. It is concluded that with conditions which permit use of the Pu/U ratio method, the correlation techniques can play an important role in the verification of total Pu input to reprocessing. The Pu/U ratio method also appears applicable to the case of plutonium thermal recycle fuels which are made up largely of uranium (>96% UO_2). However, as yet, sufficient work has not been done to provide a firm basis for evaluating the potential value of isotopic correlations and isotopic data to such fuels. Future work should be directed to this case. Other future work should be directed to expected new fuel cycles such as the ^{233}U cycle and the fast breeder cycle. (L.C.L.)

59346 (BNWL-SA–4273) SUMMARY OF EXPERIENCE WITH THE USE OF ISOTOPIC CORRELATION SAFEGUARD TECHNIQUES. Christensen, D. E.; Schneider, R. A.; Stewart, K. B. (Battelle Pacific Northwest Labs., Richland, Wash.). 20 Mar 1972. Contract ACDA/WEC-216. 66p. (CONF-720455–4). Dep. NTIS.

From Meeting on the use of isotopic composition data in safeguards; Vienna, Austria (10 Apr 1972).

Isotopic correlation safeguard techniques which have been developed to verify Pu/U ratio values are derived from burnup relationships in spent fuel data measured at the input to a chemical reprocessing plant. Relationships have been observed from all the chemical reprocessing plant isotopic data received to date at BNW and thus isotopic correlations have been applied successfully to these data. Because the physical laws governing the irradiation of nuclear fuels are immutable, isotopic relationships are a common characteristic of all spent fuels from any given reactor. It remains to be seen what the characteristics of some of the relationships will be for reactor types not yet studied and for newer fuel designs in reactors already investigated. There is, however, little doubt that relationships will be evident for all reactor fuels which will be appropriate for verifying the Pu/U ratio at the reprocessing plant input. (auth)

59347 (BNWL-SA–4274) APPLICATION OF ISOTOPIC CORRELATION SAFEGUARD TECHNIQUES TO VERIFY THE PLUTONIUM CONTENT OF HUMBOLDT BAY SPENT FUEL. Christensen, D. E. (Battelle Pacific Northwest Labs., Richland, Wash.). 20 Mar 1972. Contract ACDA/WEC-216. 54p. (CONF-720455–5). Dep. NTIS.

From Meeting on the use of isotopic composition data in safeguards; Vienna, Austria (10 Apr 1972).

A specific example is presented of applied isotopic correlation safeguard techniques. The techniques were applied to measured chemical reprocessing plant input and product data from the processing of Humboldt Bay Reactor spent fuels. The objective was to verify the measured Pu/U value of each input batch. Humboldt Bay is a boiling water reactor and the $(Pu/U)/^{235}D$ values of 6 batches of fuel evidenced a void effect. A significant development was that the isotopic correlation techniques were applied successfully through the use of several isotopic relationships each applicable where another was limited. (auth)

59348 (BNWL-SA–4276) THEORY OF PRESENT AND FUTURE SAFEGUARDS APPLICATIONS OF ISOTOPIC RATIOS. Prezbindowski, D. L. (Battelle Pacific Northwest Labs., Richland, Wash.). 20 Mar 1972. Contract ACDA/WEC-216. 73p. (CONF-720455–8). Dep. NTIS.

From Meeting on the use of isotopic composition data in safeguards; Vienna, Austria (10 Apr 1972).

Previous studies have identified certain isotopic ratios which are promising for use in verifying the Pu content in the nuclear fuels dissolved at the chemical reprocessing plant. This is especially true with ratios which are highly constant over a large range of fuel exposure. The usefulness of these isotopic ratios is that they provide a basis for intercomparing isotopic data of a wide range of exposure. One of the contributions that theory has made in the development of isotopic ratios is to reveal the physical basis for the invariance of the ratio $Pu/U/^{235}D$ in U enriched PWR fuel through simplified transmutation models. Although the simplified models give insight into the reasons for the constancy of $Pu/U^{235}D$ and a qualitative agreement with experimental data, they are not accurate and general enough to be used as a quantitative tool for safeguards. Before an accurate and general approach to the problem of constructing isotopic ratios can be defined the important question of the sensitivity of an isotopic ratio to diversion must be examined. Any one isotopic ratio will have zero sensitivity to certain types of diversion; this zero sensitivity is called a "blind spot." Methods of identifying and compensating for "blind spots" in the isotopic ratio require the solution of a system of equations which predict the possible combinations of small isotope changes that will produce no response in the isotopic ratios being used. The use of a number of distinct ratios that is greater than the number of isotopic concentrations that the diverter may conceivably manipulate insures that the "blind spots" to diversion are covered. Two or three ratios may be all that are required in practice since other constraints may eliminate many mathematically possible but practically impossible diversions. The process of constructing isotopic ratios has two objectives: the definition of the ratio and the specification of the characteristics of the ratio over a variation of reactor parameters that influence the production and depletion of isotopes being safeguarded. The construction process achieves these goals using the most accurate measured and calculated data available. The present accuracy of calculational methods is sufficient to permit them to play an important part in the development of isotopic ratios for future applications. Even the most careful construction of isotopic ratios generally leaves undesirable limitations on the constancy and range of application of the ratios. A whole new dimension for improving the constancy and reliability of the isotopic ratio method is the use of isotopic powers and coefficients to improve the isotopic ratio. The use of isotopic powers and coefficients is equivalent to having a limited capacity to adjust the basic nuclear cross sections. Examples of the application of coefficients show that a ratio $(Pu/U/^{235}D)$ with application to ^{235}U enriched PWR cores with small natural background variations (4% or less) can have these variations reduced by a factor of 1000. A ratio with applications to BWR's with larger compound variations (34% or less) has had these variations reduced to one percent or less over specified ranges of exposure and moderator void. (auth)

59349 (BNWL-SA–4439) VALIDATING SAFEGUARDS INFORMATION. Bennett, Carl A. (Battelle Pacific Northwest Labs., Richland, Wash.). Apr 1972. Contract ACDA/WEC-216. 18p. (CONF-720455–2). Dep. NTIS.

From Meeting on the use of isotopic composition data in safeguards; Vienna, Austria (10 Apr 1972).

There are three sources of information available to a national or international safeguards authority about the status of the nuclear material at any given facility. The first is validated facility information; that is, information obtained by the facility itself which the authority, through some process of verification, is willing to accept as a basis for reaching its own conclusion. The second source of information is independent measurements obtained directly by the authority through its own measurement and verification activities. The third source of information, which is in a sense unique to an over-viewing safeguards authority, is external information which may either confirm the validity of other information or add directly to the information available to the authority. It is this emphasis on the need to verify reported information and/or make independent measurements that makes methods based on the unique isotopic properties of nuclear materials so important to the International Atomic Energy Agency (IAEA). The safeguards system to meet Agency objectives proposes that "material accountancy should be adopted as the safeguards measure of fundamental importance, with containment and surveillance as important complementary measures." Each of these traditional safeguards functions can be supported by identification or tracer techniques and by measurement methods and technical cross checks based on isotopic information. It is suggested that some of the indirect benefits to both the agency and the signatory powers through an improved ability to resolve legitimate inconsistencies at an early stage are greater than generally realized, and may be well worth the costs involved. (L.C.L.)

59350 (EUR-4833) FOUR COMPUTER CODES FOR DYNAMIC PROCESS INVENTORY DETERMINATION APPLICATION IN SAFEGUARDS. Rota, A. (European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center). Sep 1972. 104p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 150.-.

The following computer codes are described and listed. For each of them a sample program is solved. GROUP—for the optimization of the grouping of fuel elements to be reprocessed. CC2—for the computation of the contribution to the physical inventory of the "two component" mixture. CC3—for the computation of the contribution to the physical inventory of the "three component" mixture. MUF—for the final evaluation of the material unaccounted for (MUF) and its error limits, within a prescribed confidence level. (auth)

59351 (GEAP-12283) MEASUREMENT ERRORS IN SEVERAL PLUTONIUM ASSAY METHODS BASED ON A BALANCED STAGGERED NESTED DESIGN. Hagie, L. T.; Bishop, D. M.; Nelson, W. B.; Robles, M. N.; Wadekamper, D. C. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Mar 1972. Contract AT(30-1)-68. 52p. Dep. NTIS.

The random measurement errors associated with plutonium assay methods for mixed oxide pellets were determined from 36 samples. The methods studied were controlled potential coulometry and five variations of two nondestructive assay techniques (gamma and neutron counting). It was shown that minimum measurement errors for a single determination of 0.21% relative were obtained by controlled potential coulometry for Pu/MO_2 while errors were on the order of 0.8% relative for gamma counting, and 1 to 2+% relative for neutron counting. The total measurement error including variation in sampling was estimated to be 0.28% relative. A bias in the controlled potential coulometer results of 0.015% relative was also observed in the determination of paired pellets analyzed during two different time periods. Gamma counting was more sensitive to sample configuration than neutron counting. (auth)

59352 (RFP-1368) EFFECTS OF SPATIAL AND ANGULAR RESOLUTION IN DISCRETE ORDINATE CRITICAL-MASS CALCULATIONS. Coonfield, Donald C.; Hunt, Douglas C. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 5 Sep 1972. Contract AT(29-1)-1106. 9p. Dep. NTIS.

The criticality engineer often needs accurate criticality parameters at minimum cost in time and money. To aid in satisfying these requirements, a systematic study is presented of the effects of varying the number of spatial intervals and the number of angular directions in discrete ordinates critical-mass calculations on reflected and moderated systems. The calculations are done by varying the spatial and angular meshes in the Computer Code DTF-II. The results obtained are compared with experimentally measured critical masses. Based on these comparisons and on the asymptotic behavior of computed critical masses as the space-angle mesh is refined, criteria for space-angle mesh specification are obtained. One specific conclusion is that for all the systems studied S_{16} calculations are necessary. (auth)

59353 SAFEGUARDS ON THE FUEL CYCLE: BURDEN OR BULWARK. Crowson, D. L. (Atomic Energy Commission, Washington, D. C.). pp 289-300 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

The history and statutory responsibility of the safeguards program are briefly reviewed, and safeguards research and development is discussed, with particular emphasis on the United States domestic safeguards system. Changes anticipated are outlined. (P.C.H.)

Disposal and Storage

59354 (CEA-CONF-2017) PRESENT SITUATION AND OUTLOOK CONCERNING RADIOACTIVE WASTE DISPOSAL. Sousselier, Y. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 5 Apr 1972. 8p. (In French). (CONF-720453-1). Dep. NTIS (U. S. Sales Only).

From Meeting on radioactive waste disposal; Paris, France (12 Apr 1972).

The radioactive waste produced in western Europe in 1970 amounted to several thousand cubic meters, almost all of this quantity being composed of low activity (10 to 100 millicuries/m^{-3}) wastes. The quantities of radioactive materials stored were small in comparison with the storage capacity of the environment. The likely evolution in the production of electricity of nuclear origin and the annual output of ^{90}Sr, ^{137}Cs, and ^{85}Kr were studied. The politics behind the storage and treatment of the solid waste system adopted is presented: storage of short half-life materials at the surface (low-activity materials), or in salt, or similar formations, or in sealed cavities (high-activity wastes); sinking into holes in the sea bed or storage in salt formations (long half-life nuclides). A certain amount of international control of storage centers seems desirable. (France)

59355 (TID-26166) EVALUATION OF THE CONCEPT OF STORING RADIOACTIVE WASTES IN BEDROCK BELOW THE SAVANNAH RIVER PLANT SITE. (National Academy of Sciences, Washington, D. C.). 1972. Contract AT(11-1)-3053. 91p. Dep. NTIS. National Academy of Sciences, Washington, D. C. $3.25.

The highly radioactive wastes aged in tanks at the Savannah River Plant (SRP) site must ultimately be transferred to some facility that offers effective retention for centuries. A solution under consideration is to store these wastes in vaults in the rocks deep beneath the site. For such long-term retention of radioactive wastes, precise information is needed on the hydrologic systems in the bedrock, on the regional stress fields, on the structural integrity of mined openings, and on the chemical compatibility between the wastes and potential host rocks. It is also apparent that this needed degree of precision cannot be adequately obtained by exploration from the surface supplemented by a limited number of borings. This statement in no way diminishes the usefulness of the exploration from the surface, the chemical and physical tests, borings, and hydrologic calculations so far made. It reflects, rather, the fact that the metamorphic basement rocks, and the sedimentary rocks of Triassic age underlying the site, are neither uniform nor homogeneous and cannot be evaluated with precision from limited samples. The information acquired to date indicates a potential for a safe storage facility, but, in view of the intensity of the radioactivity of the material to be stored and the length of time required, the only prudent course is thorough exploration before final decision. The recently acquired data on the sedimentary rocks of Triassic age are encouraging and emphasize the need for complete exploration. Information from in situ exploration of the potential host rocks will be essential for development of an environmental-impact statement. Such in situ exploration is possible only by the construction of a shaft to the proposed depth and the excavation of tunnels. The proposed shaft and tunnels would serve several purposes. First, and most critical, such exploratory excavations would permit the examination and study of the host rock throughout the extent of the proposed vaults. Extrapolation of rock conditions from the walls of a small tunnel to a full-sized vault is reasonably certain, in contrast to the less certain extrapolation of rock conditions from borings hundreds of feet apart. Also, it will be possible to make chemical and physical analyses of the rock throughout the entire dimension of the proposed vaults. Further, before the final decision is made to develop a full-scale storage facility, exploratory excavations will make possible observation of water movement in the host rock over a significant period. In addition, digging an exploratory shaft would identify the problems of engineering design and construction in penetrating the highly permeable water-bearing Tuscaloosa Formation that overlies the basement rocks. Because this is a primary regional aquifer, there must be assurance that a watertight shaft can be constructed through it and can be maintained. The decision as to whether the exploratory shaft should be located in the metamorphic rocks or in the Triassic sedimentary rocks will depend on results of geological, geophysical, and geochemical investigations yet to be completed. Preliminary data suggest that the Triassic rocks are not extensively fractured, but the presence and spacing of joints and faults would be disclosed by the lateral tunnels. The physical, chemical, and engineering properties of the Triassic rocks are not adequately known, and exploratory excavations would facilitate their thorough study. If data from the exploratory shaft and tunnels do not clearly confirm that use of excavated vaults is safe for long-term isolation of SRP wastes from the biosphere, the concept as herein defined would become invalid. (auth)

59356 DEVICE FOR DILUTING RADIOACTIVE EXCREMENT BEFORE ITS DISPOSAL. (to Etablissements Lemer et Compagnie). French Patent 1,604,662. 11 Feb 1972. Filed 19 Nov 1968. (In French).

An assembly for separating radioactive liquid and solid excrement is described. A special bowl system is used in conjunction with a tank separated into different compartments. This tank enables the liquid excrement to be stored and its level of radioactivity to be reduced in a controlled way. The waste is considerably diluted before being released to sewers. In this way, waste can be disposed of in accordance with existing regulations. (France)

59357 DISPOSAL OF WEAKLY-ACTIVE SOLID WASTES IN UNLINED GROUND TRENCHES. Bashmakova, T. A.; Rodionova, L. F. (Leningrad Scientific-Research Inst. of Radiation Hygiene). Gig. Sanit.; No. 6, 105-6(Jun 1972). (In Russian).

Experimental justification was sought for the use of unlined ground trenches for burying low-level solid waste, where the aquiferous level was at a depth of 70 to 100 m. Absorption tests with ^{90}Sr, ^{137}Cs, and ^{144}Ce were conducted on soil samples. The radioactivity in the waste was distributed nonuniformly and ranged from 10^{-4} to 10^{-8} Ci/kg of solids. The trenches were 3.5 m deep, 1 m wide and 10 m long. Observations were made on the migration of radioisotopes into the surrounding soil up to 2 y after burial; no significant quantity was detected. (K.S.W.)

59358 ASSESSMENT OF FILTRATION FIELDS RECEIVING SEWAGE CONTAINING RADIOACTIVE SUBSTANCES AT PERMISSIBLE CONCENTRATIONS. Zhakov, Yu. A.; Orlova, E. I.; Kuznetsova, G. A.; Baranov, M. A.; Lyapina, Z. E. Gig. Sanit.; No. 6, 38-40(Jun 1972). (In Russian).

When domestic-fecal sewage containing ^{137}Cs and ^{60}Co at an average annual permissible concentration was discharged to filtration fields, radioactive isotopes were found to accumulate in the upper sand layer. The consequent accumulation levels were so high that the upper contaminated sand layer was handled as radioactive waste. (auth)

Handling Equipment and Procedures

59359 TRANSFER DEVICE. Menissier, Pierre; Pajot, Jacques (to Commissariat a l'Energie Atomique). French Patent 2,092,807. 28 Jan 1972. Filed 19 Jun 1970. (In French).

A device for transferring radioactive objects from an enclosure into a container is described, the transfer of nuclear fuel pellets being of principal interest. The device involves transferring the radioactive object inside a tube having the same dimensions as the aperture of the container. The device is provided with a flexible belt (forming a sealed joint) and a means of driving this belt from the outside into the interior of the enclosure, a path being chosen such that successive holes in the belt pass in front of the tubular passage. The belt is supplied with centralizing facilities associated with each hole. (France)

Transportation

59360 (DPSPU-72-124-5) SAFETY ANALYSIS REPORT: PIQUA-ELK RIVER SHIPPING CASK (PACKAGING OF RADIOACTIVE AND FISSILE MATERIALS). Final Report. Evans, J. E.; Langhaar, J. W. (comps.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Oct 1972. Contract AT(07-2)-1. 69p. Dep. NTIS.

Irradiated fuel from the NS Savannah can be loaded dry in the Piqua-Elk River cask equipped with a new poison insert and shipped as Fissile Class III material in compliance with AEC Manual Chapter 0529 (AECM 0529), "Safety Standards for the Packaging of Radioactive and Fissile Materials." The evaluation of the cask with the new insert for shipping spent NS Savannah fuel is presented. (auth)

59361 BOX FOR RADIOACTIVE MATERIALS. Blum, Paul (to Transnucleaire Societe pour les Transports de l'Industrie Nucleaire). French Patent 2,097,060. 3 Mar 1972. Filed 30 Jul 1970. (In French).

The design of packaging for storing and transporting radioactive materials is presented. The composite wall of this packaging consists of an inner steel shell, a layer of dense material (e.g., Pb) for protection against γ radiation, and an outer shell. The packaging also contains a neutron absorbing material in which fin or gudgeon-shaped heat conductors are buried. The neutron absorbing material may be polythene colemanite, pandermite, boric acid or sintered boron glass. (France)

59362 SHIPMENT AND REPROCESSING OF IRRADIATED POWER REACTOR FUELS. Smith, C. Wesley. pp 137-51 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

The current status of commercial reactor fuel shipping and fuel reprocessing and the projection of light-water reactor requirements and trends for the future are discussed. Special attention is directed to the provisions made to assure effective separation and continued isolation of radioactive by-products from personnel and from the environment; to the verification of improved fuel cycle economics through recycle of the recovered products as market demands develop; and to the preservation of national energy resources, since the irradiated fuel discharged contains about 50% of the fissile material required for a reload batch. (P.C.H.)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 58955, 59395, and 60153.

59363 (CEAL–3063-1) SEMIANNUAL REPORT FOR THE PERIOD JULY 1–DECEMBER 31, 1971. Strauch, K.; Shurcliff, W. A. (Cambridge Electron Accelerator, Mass.). 15 May 1972. Contract AT(30-1)-2076. 38p. Dep. NTIS.

The number of 8-hour shifts devoted to (a) studies of beam accumulation and storage, and (b) maintenance, installation of new equipment, and unscheduled downtime is indicated. The advances made in the development of the colliding beam facility, including (a) control of beam resonances, instabilities and beta-function-at-interaction-region with the object of increasing the limits on peak currents and peak luminosity, and (b) increasing the reliability of control and the speed of accumulating beams and switching them into the bypass, with the object of increasing the long-term average luminosity attainable are described. Regarding (a): instabilities were controlled to the extent that a weak (~1 mA ave) e^+ beam could be maintained in the ring in the presence of a 50-mA-peak, 8-mA-ave e^- beam; a single e^- beam current as large as 19 mA ave was established in ring-plus-bypass. Luminosity was observed with 2-geV beams and also 3-GeV beams. With 2-GeV beams, a luminosity of 0.4×10^{28} cm^{-2} sec^{-1} was obtained with a 3-mA-ave e^+ beam and a 4-mA-ave e^- beam. Regarding (b): the process of beam accumulation, ramp-up, and switching into the bypass was automated to such an extent that the efficiency of particle retention exceeded 80% and the entire process took ~5 minutes. The bypass on-line detector (BOLD) which was ready for use on short notice, and the magnetic on-line detector (MAGNOLIA), designed to be effective in the analysis of hadron events are described. Repairs and improvements to the accelerator proper are discussed, and other programs and the major publications are listed. (auth)

59364 CONCERNING THE CAUSE OF THE APPEARANCE OF AN ELECTRONIC LOAD IN ACCELERATOR TUBES OF ELECTROSTATIC ACCELERATORS. Zheleznikov, F. G.; Yakovlev, N. M.; Bersenev, Ya. T.; Garenkov, V. S. (Scientific-Research Inst. of Electrophysical Equipment, Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 36-8(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 41-3(1972).

It was shown experimentally that the conductivity of vacuum insulation may be caused by emission spots which develop on the surface of the cathode electrode due to the action of discharge phenomena. The development of leakage currents ("electronic glow") in accelerator tubes can be explained by the presence of dielectric films which contaminate the electrodes and are capable of emitting electrons in fields ~10^4 V/cm. (auth)

59365 OPTIMIZATION OF A HIGH-CURRENT ION ACCELERATOR. Zubkov, I. P.; Kislov, A. Ya.; Morozov, A. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 712-14(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 898-900(Apr 1972).

It is possible to reduce the length of the ionization region and improve the compensation of the angular momentum of the emerging ions, with the result that the angular divergence of the output plasma of a two-lens accelerator is reduced appreciably. An important result is revealed by an investigation of modifications of the accelerator with one, two, and four lenses. The discharge voltage can be increased without changing the discharge current. (auth)

59366 POSSIBILITIES OF THE USE OF A 6-MeV PORTABLE MATERIAL TESTING BETATRON IN HUNGARY. Hirling, J.; Szili, S. (MTA Izotop Intezete, Budapest). Izotoptechnika; 15: No. 5, 235-54(May 1972). (In Hungarian).

Topics include betatron physics, the new PMB-6 type betatron of the Institute of Isotopes, possibilities of its application, and conditions for optimal quality radiographic pictures. (auth)

59367 TECHNICAL AND ECONOMIC CONDITIONS CONCERNING THE OPERATION OF AN IRRADIATION CENTER EQUIPPED WITH AN ELECTRON LINEAR ACCELERATOR AND SPECIALIZED IN THE RADIOSTERILIZATION OF MEDICAL MATERIALS. Icre, P. (Societe de Recherches Techniques et Industrielles, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 93, 39-46(Jan 1972). (In French).

From Meeting on sterilization techniques of medical and surgical instruments by ionizing radiations; Lyon, France (18 Nov 1971). See CONF-711144.

The center for the Applications of Ionizing Radiations of Corbeville (CARIC) is equipped with a TH-CSP CIRCE 10 linear electron accelerator. An energy of 6 MeV is produced using a 7 kW power dissipation. The surface and depth efficiencies obtained when this accelerator is used for radiosterilization are given. The speed at which such a treatment can be carried out is discussed together with the total handling capacity of the system. The level of the irradiation is controlled by the appropriate adjustment of the accelerator and electron beam; the irradiated products are subjected to dosimetry. (France)

Auxiliaries and Components

59368 (BNL–17190) MAGNETIC MEASUREMENTS OF SUPERCONDUCTING SYNCHROTRON MAGNETS. Sampson, W. B.; Dahl, P. F.; McInturff, A. D.; Morgan, G. H. (Brookhaven National Lab., Upton, N. Y.). 1972. 6p. (CONF-720908–3). Dep. NTIS.

From fourth international conference on magnet technology; Upton, NY. (19 Sep 1972).

The harmonic content of a number of superconducting iron-shielded dipoles has been measured. Low field measurements have been made at 60 Hz and at temperatures of 300 K, 77 K, and 4.2 K. High field measurements have been made at 4.2 K for both dc and pulsed operation. Two harmonic coils have been used, a long coil which includes the effects of the magnet ends, and a short coil which measures the two-dimensional field distribution. The data include the field dependence of sextupole, decapole, fourteen pole and eighteen pole components to a maximum field of 40 kG. In addition, data are presented on the residual field (trapped field) distribution and the external or leakage field just outside the iron shield. (auth)

59369 (CERN–72-15) CONTROL OF RADIOACTIVE POLLUTION IN THE ENVIRONMENT OF THE CERN ACCELERATORS. Prantl, F. A.; Baarli, J. (European Organization for Nuclear Research, Geneva (Switzerland)). 28 Aug 1972. 45p. Dep. NTIS (U. S. Sales Only).

A brief review of the methods developed and some results obtained concerning the environmental monitoring of radiation and radioactivity on the CERN site are reported. Systematic investigations of these problems are necessary in order to ensure that the radiation safety precautions are adequate and that the influence on the environment is known and remains within the prescribed limits. Air, dust, and effluent-water radioactivity from the CERN accelerators is barely detectable at a distance of 350 m from the accelerators and represents a very small contribution to the environmental radioactivity of the surroundings. (auth)

59370 (SLAC-PUB–949) MULTIPROGRAMMING SYSTEM FOR PROCESS CONTROL. Howry, Sam (Stanford Linear Accelerator Center, Calif.). Aug 1971. 9p. (CONF-711057–1). Dep. NTIS.

From third ACM symposium on operating systems principles; Stanford, CA. (Oct 1971).

An operational small computer multiprogramming system developed for the control of the Stanford Two Mile Linear Accelerator (SLAC) is described. The system has many features of larger systems such as dynamic memory allocation and interprocess control, but does not have to handle typical batch type jobs which need large arrays and many other system resources. This difference results in a drastic reduction in the complexity of both design and implementation. The accelerator control problem is discussed in terms of what requirements are imposed on the system by the environment. Then the basic subsystems are described with sufficient examples to show the reader other areas where such a system may be applicable. (auth)

59371 STABILIZED THYRISTOR CONVERTER WITH DIGITAL CONTROL. Gusev, O. A.; Kolesov, S. Ya.; Tunkin, A. A. (Scientific-Research Inst. of Electrophysical Equipment, Leningrad). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 142-3(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 128-9(1972).

A thyristor converter is described which is used as a source for stable supply of various devices in electrophysical installations such as electromagnets in accelerators. The instrument is controlled by a binary code from an electronic computer. (auth)

59372 CENTRIFUGAL METHOD OF FABRICATING ACCELERATOR TUBES. Solodovnikov, A. P. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 39-40(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 44-5(1972).

A method is proposed for centrifugal casting of insulators for cylindrical accelerator tubes in a rotating mold. The connection of the insulators to the electrodes takes place during the process of tube fabrication. (auth)

59373 SILICON RECTIFIER CHAINS FOR ACCELERATING VOLTAGE SUPPLIES. Hanna, N. N. (Atomic Energy Establishment, Inshas, Egypt). Int. J. Electron.; 33: No. 4, 457-63 (Oct 1972).

Silicon rectifiers, when cascaded in series to provide a high peak inverse voltage rating, depletion capacitance, and saturation current, create some problems regarding over-voltage protection of the rectifiers. These problems are discussed and possible solutions suggested for systems operating at high supply frequencies. Expressions and curves are given for the design of protected rectifier chains suitable for the high voltage supply of particle accelerators. (auth)

59374 CAMAC OPERATING SYSTEM FOR CONTROL APPLICATIONS. Mertens, B. (Kernforschungsanlage, Juelich, Ger.). CAMAC Bull.; No. 2, 19-20(Nov 1971).

A simple CAMAC operating system has been developed using FORTRAN to a large extent. This software allows the handling of the CAMAC control system associated with the Juelich isochronous cyclotron on the basis of a symbolic language. Additional features include three levels of different priority, definitions of symbolic programs in real time and assignment of these programs to the different levels in real time. Great emphasis has been placed on reliability and error detection. (EURATOM)

59375 USE OF A SOLID-STATE PROBE TO DETECT CHANGES IN OPERATING PARAMETERS OF AN 8 MV LINEAR ACCELERATOR. Wright, Ann E.; Gager, L. D.; Hudgins, P. T. (Baylor Univ., Houston, Tex.). Radiology; 105: No. 1, 201-3 (Oct 1972).

Advantages gained by bending the beam of a linear accelerator are achieved at the expense of increased operational complexity. Changes in beam energy and field uniformity with time may go undetected unless specific checks are made. Silicon diode scans of the x-ray field have detected conditions under which significant departure from the planned dose could occur, indicated necessary design modifications, and minimized unscheduled down-time. (auth)

Ion Sources, Injection, and Extraction

Refer also to abstract 58881.

59376 CONSTRUCTION OF THE CURRENT-CONDUCTING PLATE OF SEPTUM-MAGNETS. Globenko, Yu. G.; Lapitskii, Yu. Ya. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 33-5(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 39-41(1972).

The construction of the hollow current-conducting plate of septum-magnets is considered. It is shown that the replacement of the channels for cooling a single cavity allows reduction of the plate thickness and improvement of the field uniformity in the working region (i.e., it allows the efficiency of slow extraction to be increased, and the quality of the extracted beam to be improved). (auth)

59377 DEBUNCHER OF THE INJECTOR OF THE JOINT INSTITUTE OF NUCLEAR RESEARCH SYNCHROPHASOTRON HAVING MODULATION OF THE ACCELERATED-BEAM ENERGY. Beznogikh, Yu. D.; Zinov'ev, L. P.; Kadyrov, R. B.; (and others) (Joint Inst. of Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 30-2(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 37-8(1972).

The basic results of calculating the efficiency of injection into the synchrophasotron of the Joint Institute of Nuclear Research for energy modulation and reduction of the energy scatter of the injected beam using a debuncher are given. A brief description is presented of the debuncher, and the basic experimental results obtained during the process of debugging and experimental operation on the synchrophasotron is presented. (auth)

59378 NUMERICAL DESIGN OF AN OPTIMUM WAVEGUIDE ELECTRON BUNCHER. Ovsyannikov, D. A. (Leningrad State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 556-7(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 705-7(Apr 1972).

A numerical method is given for deriving the phase velocity and electric field as functions of distance along the guide by minimizing the spreads in phase and energy at the buncher output. Results are presented to show the feasibility of designing beams with good characteristics. (auth)

59379 MEASUREMENT OF CATHODE LOSSES IN A MICROTRON. Kosarev, E. L. (Inst. of Physics Problems, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 662-4(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 841-3(Apr 1972).

Measurements of the cathode losses in a pulsed microtron are described. These losses are approximately 400 kW per ampere of injector current. (auth)

59380 SOURCE AND BEHAVIOR OF SPURIOUS F^+ SIGNALS IN ELECTRON IMPACT ION SOURCES. Yates, John T. Jr.; King, David A. (Univ. of East Anglia, Norwich, Eng.). J. Vac. Sci. Technol.; 9: No. 5, 1256-8(1972).

Observations of the transfer of fluorine-containing impurities from one surface to another in ultrahigh vacuum are reported. The work was carried out during the course of electron impact studies on a single-crystal W surface. It was found that fluorine-containing species may be trapped by a thoria—W electron emitter during system processing at bakeout temperatures. Upon heating the emitter to operating temperature (about 1600 to 1800°K), transfer of the unknown species occurs to other surfaces, where detection of F^+ by electron impact desorption occurs. The transfer species is most likely neutral. While the ultimate source of F and Cl is unknown in ultrahigh vacuum systems, these impurities may, in some cases, originate from stainless steel surfaces pickled during manufacture with HF or HCl-containing solutions, or in glass systems cleaned with HF. The occasional detection of a Na^+ peak suggests that alkali halides may be among the volatile species responsible for transfer of halogens to the thoria emitter during bakeout. It was shown that, following bakeout, the impurity source of spurious F^+ observed during electron impact may be eliminated by successive and thorough outgassing of the thoria—W emitter and the surface undergoing electron impact. (4 figures, 1 table) (R.W.R.)

Ion Optics and Field Calculations

Refer also to abstract 60490.

59381 FREQUENCIES OF COHERENT TRANSVERSE OSCILLATIONS IN THE ELECTRONIC MODEL OF A RING CYCLOTRON. Kochkin, V. A.; Novikov, D. L.; Onishchenko, L. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 24-6(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 31-3(1972).

Calculated values of the frequencies of transverse oscillations of the center of gravity of the beam are presented for several versions of the magnetic field, as well as the results of an experimental determination of these frequencies by the method of resonance buildup. (auth)

59382 SYNCHROTRON INSTABILITY OF A MODULATED BEAM OF CHARGED PARTICLES. Grigor'ev, V. P. (Tomsk Polytechnic Inst., USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 546-51(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 691-8(Apr 1972).

A study is made, in the self-consistent field approximation, of the longitudinal stability of a bunched beam whose motion is determined jointly by an external rf field and its own coherent synchrotron radiation. Dispersion equations are derived; possible modes of oscillations are found and the instability limits are determined for motion of the beam in an unbounded space and in between two bounded plane-parallel, conducting plates. (auth)

59383 SELF-PHASING OF AN ELECTRON BEAM IN A SLOW-WAVE SYSTEM. Kisletsov, A. V.; Lebedev, A. N. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 552-5(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 699-704(Apr 1972).

The steady-state solution is discussed for the self-consistent problem of fields excited by an intense relativistic electron beam in a slow-wave system. Under certain conditions the beam can form steady-state bunches localized along the direction of motion and influenced only by the intrinsic fields. The characteristics of this state are found. (auth)

59384 RADIATION FROM ELECTRON BUNCHES INTERACTING WITH AN IRIS-LOADED WAVEGUIDE. Gross, L. P.; Gusarov, V. N.; Shal'nov, A. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 564-7(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 716-20(Apr 1972).

Equations are derived for the spectral density of the radiation from a current pulse formed by particles from a linear electron accelerator that interact with an iris-loaded waveguide of length L. The problem is solved in the approximation of specified motion. The results of numerical computations are given for the difference in the repetition frequency of the bunches and the resonance frequency of the waveguide for different pulse lengths; these are compared with the results of an experiment. (auth)

59385 FIELD OF AN ELECTRON RING IN A RESONATOR. Orlov, A. K. (Scientific-Research Inst. of Electrophysical Instrumentation, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 702-641944(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 888-92(Apr 1972).

The electric and magnetic field distributions in an electron bunch in the form of a rotating ring moving through a closed resonator with velocity v are computed for application to the acceleration of heavy particles by the field of a rotating electron ring (collective acceleration method). In contrast to the quasistatic case ($v \ll c$), the attractive magnetic forces do not balance electric repulsion for $v = c$. Longitudinal forces that are approximately equal (in magnitude) act on protons trapped in the ring and on the rotating electrons. (auth)

59386 LIMITING CURRENTS IN ELECTRON BEAMS WITH RELATIVISTIC ENERGY SPREAD. Bogdankevich, L. S.; Rukhadze, A. A.; Tarakanov, V. P. (Lebedev Physics Inst., Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 715-16(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 900-1(Apr 1972).

The stability of a compensated electron beam with relativistic energy spread of the particles in a cylindrical drift space in an intense, longitudinal magnetic field is studied. The limiting current for a compensated electron beam with a relativistic energy spread is determined. It appears that the value of this current is larger than that for a monoenergetic beam by a factor of T/mc^2. (W.H.K.)

59387 LIMITING CURRENTS IN COMPENSATED ELECTRON BEAMS WITH RELATIVISTIC PARTICLE ENERGY SPREAD. Bogdankevich, L. S.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 3, 899-904(Sep 1972). (In Russian).

Stability of a compensated electron beam with a relativistic spread of particle energies in a cylindrical drift space located in a strong longitudinal magnetic field is investigated. It is shown that for $u \ll c$ (u is the directed beam velocity) the development of a weakly increasing kinetic instability, similar to the familiar ion-sound instability of a current plasma, should be possible in such a system. The frequency and increment of unstable oscillations in this case are much smaller than ω_{Li}, the Langmuir ion frequency. For $u \to c$ the kinetic instability becomes aperiodic, its increment exceeds ω_{Li}, and it gradually changes into hydrodynamic instability which is predominant only for ultrarelativistic velocities when $\ln 2\gamma \gg 1$, where $\gamma = (1 - u^2/c^2)^{-1/2}$. The hydrodynamic instability in this case is of the order of the aperiodic kinetic instability increment. Longitudinal currents which are T/mc^2 times greater than the respective limiting currents of the monoenergetic electron beams are determined on basis of the condition of development of electrostatic instabilities. (auth)

59388 STABILITY LIMITS OF THE PHASE OSCILLATIONS IN A MICROTRON. Turrin, A. (CNEN, Frascati, Italy). Nucl. Instrum. Methods; 104: No. 1, 169-72(1972).

The finite-difference equations existing in the literature for phase oscillations in a microtron are discussed first. It turns out that these equations are incorrect. A technique is then developed to analyze the effect of computing the stability limits with the aid of these equations. It is shown that the resulting phase stable regions really constitute a wrong result. A new treatment of the phase oscillations in a microtron is given. The stability limits are derived from the general theory of phase oscillations. The results are: (1) The range of equilibrium phase angles extends from 0° (corresponding to a peak voltage across the gap $V' = m_0c^2/e$) up to 90° (corresponding to very high peak voltages). (2) The bucket area is an increasing function of the peak voltage. (3) At high peak voltages stable oscillations are connected with large radial excursions from the synchronous orbit. (auth)

59389 COMPUTER SIMULATION OF CHARGED PARTICLE BEAMS. Carey, D. C. (National Accelerator Lab., Batavia, Ill.). Nucl. Instrum. Methods; 104: No. 1, 173-8(1972).

A computer program has been designed to simulate charged particle beam transport systems. It allows evaluation of the effect of aberrations which exist in beams with small phase space volume. These include higher order chromatic aberrations, effects on non-linearities in magnetic field, and higher order geometric aberrations due to the accumulation of second order effects. The beam at any point in the system may be represented by one- and two-dimensional histograms. (auth)

Storage Rings

59390 (BNL-17148) ANTIPROTON INTENSITIES AT ISA. Foelsche, H.; Hahn, H. (Brookhaven National Lab., Upton, N. Y.). 24 Aug 1972. 6p. (CRISP-72-63). Dep. NTIS.

In the Intersecting Storage Accelerator (ISA) an antiproton beam with an intensity of approximately 3×10^9 antiprotons appears feasible without resorting to electron cooling. The beam is produced realistically by straightforward matching of target phase space into the accelerator. A target is placed into a proton beam of 200 GeV taken from one of the storage rings. Antiprotons of about 30 GeV are produced and captured in the second ring and accelerated to 200 GeV. The first ring is refilled with protons in the opposite direction, and antiproton-proton collision are induced. The full acceptances of the rings are filled in both cases at 30 GeV, and due to adiabatic damping the beams attain the same small size as in conventional use at 200 GeV. (auth)

59391 (NP-19374) TWO EXAMPLES OF NONLINEAR EFFECTS IN ELECTRON AND POSITRON COLLISION RINGS. Jejcic, Alain (Paris Univ., Orsay (France)). Feb 1972. 92p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Two studies on nonlinear phenomena in collision rings are presented. The first pertains to third-order nonlinear resonances of focusing and guide fields. The case considered is the one where the functioning point is found in proximity to or on a third-order resonance. It is shown that, according to the initial state of the particle, the amplitude can be defined sufficiently so that there is loss on the wall of the vacuum chamber. For greater rigor the fourth-order non-linearities, which attenuate the effect of the third-order resonances, are considered. An attempt is made to define a resonance length which can be compared to the results of experimental studies on collision rings. The second study is devoted to nonlinear effects which appear during the interaction of two beams having Gaussian transverse densities. The total expression of the nonlinear space charge force was undertaken in order to define rigorously the distribution function of the betatron frequencies for various interaction geometries. Because of the complexity of the calculations the study of the evolution of the amplitudes was only qualitative. (tr-auth)

Experimental Facilities

Refer also to abstracts 58662 and 59693.

59392 (DESY-72/43) PROTON POLARIZATION IN ALCOHOLS AT 50 KG, 1° K. Hartmann, G.; Hubert, D.; Mango, S.; Morehouse, C. C.; Plog, K. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Aug 1972. 16p. Dep. NTIS (U. S. Sales Only).

Proton polarization $P_n \sim 80\%$, polarization build-up times $\tau_n \sim 2'$ and relaxation times $T_n \sim 40'$ have been repeatedly obtained at 1°K and 50 kG in 1-butanol— and 1-pentanol—water mixtures doped with porphyrexide. Shorter (or longer) T_n's and τ_n's can be obtained by varying the target composition, when accepting a certain loss in polarization. (auth)

59393 (LNF-72/14) NOTES ON ORIENTATION OF NUCLEI. Montelatici, V. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 16 Feb 1972. 56p. (In Italian). Dep. NTIS (U. S. Sales Only).

The theoretical and experimental methods which make it possible to understand the phenomenology of dynamic polarization are reported. Parameters of orientation and the static method are discussed. Dynamic polarization and the role of magnetic dipole interaction are then considered. A scheme of dynamic polarization is given with an evaluation of the orders of magnitude of the orientation parameters. The solid effect theory is discussed with a consideration of relaxation in ionic crystals and the thermodynamic viewpoint. The modern theory of magnetic resonance and the results of the Provotorov theory are discussed. The phenomenology of the thermal mixing between two spin systems is given. The resolved solid effect, the stationary solution, and the nonresolved solid effect are considered. (19 figures) (J.S.R.)

59394 PRECISION MONITORING OF NEUTRONS FROM THE T-D- AND D-D-REACTIONS. Andreev, E. A.; Blazhenkov, V. V.; Sit'ko, S. P.; Shevchenko, V. A. (Kiev State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 73-5(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 72-4(1972).

An instrument is described which allows precision monitoring of the neutron flux from the $T(d,n)^4He$ and $D(d,n)^3He$ reactions to be monitored with an accuracy of better than 3%. Using the procedure of recording and counting ^{4}He and ^{3}He particles which accompany the emission of neutrons, it was possible to establish a one-to-one relationship between the number of neutrons obtained as a result of the reaction and the number of recorded ^{3}He and ^{4}He particles. For irises which cut out an angle of $4\pi \cdot 10^{-4}$ sr for TD-neutrons and $4\pi \cdot 10^{-3}$ sr for DT-neutrons the given procedure allows a monitoring to be carried out for a reaction yield ranging from 10^3 to $5 \cdot 10^{10}$ neutrons/sec. The use of a surface-barrier Si-detector, a current amplifier, high-frequency transistors, and tunnel diodes allows the output pulses of the instrument to be used for time "locking" to the instant of neutron emission from the target with an accuracy of $(1 \text{ to } 2) \cdot 10^{-9}$ sec. (auth)

59395 LAMPF: EXPLORING THE MEDICAL POTENTIALS OF NEGATIVE PIONS AND NEGATIVE MUONS. Rosen, Louis (Los Alamos Scientific Lab., N. Mex.). Nucl. News; 15: No. 9, 56-61(Sep 1972).

Design and performance specifications for the Los Alamos Meson Facility (LAMPF) are summarized. Means for attacking outstanding problems in basic nuclear science and possible new procedures and new isotopes for medical use offered by the facility are discussed. Medical potentials of negative pions and negative muons are explored. Advantages foreseen for negative pions are tabulated, and some possible uses of mu-activation analysis are listed. (F.S.)

59396 ON-LINE APPLICATION OF A COMPUTER IN A HIGH-ENERGY PHYSICS EXPERIMENT. Moritz, J. KFK Nachr.; 4: No. 2, 10-13(1972). (In German).

On the German electron synchrotron in Hamburg, experiments were conducted which study the structures of protons and neutrons by means of electron scattering. In these experiments, a process computer was used for collection and preliminary analysis of measuring data. Particle tracks were measured behind a deflector magnet through scintillation counters, a Cherenkov counter, a shower counter, and spark chambers. From angle and impulse measurements of single scattering events, cross sections were computed. The computer permitted rapid data collection as well as immediate use of the data for readjustment of the apparatus, control of the measuring program, and swift recognition of errors. The design of the computer, programming, and several experimental examples are described. (H.B.G.)

59397 90 CM SCATTERING CHAMBER WITH NOVEL DESIGN FEATURES. Verbruggen, R.; McMurray, W. R. (Southern Universities, Faure, S. Afr.). Nucl. Instrum. Methods; 104: No. 1, 197-203(1972).

A 90 cm scattering chamber has been designed and constructed for general use in a Van de Graaff accelerator laboratory. The design had to be simple, inexpensive and large enough to allow for charged particle time of flight experiments. To enable its construction in a small workshop it was made with flat aluminium plate in an octagonal shape. Unusual O-ring seals have proved their reliability over 3 y of operation. The chamber lid is opened easily on a hinge arrangement. The target and detector assembly is supported separately on a rigid structure to maintain positional precision. A simple vacuum lock enables targets to be changed in minutes without breaking the main vacuum. Other features include external adjustment of radial and angular positions of detector supports on two arms, external adjustment of target position and angle and provision for automation of these functions. This low budget chamber has proved to be robust and simple to operate. (auth)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Cosmic Radiation

Refer also to abstracts 59515, 59516, and 59686.

59398 (AECL–4207) COSMIC RAY MT-64 MUON MONITOR DATA. VI. From Solar Rotation 1867 to Rotation 1879, January 17, 1970–January 2, 1971. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Apr 1972. 93p. Dep. NTIS (U. S. Sales Only). AECL $2.00.

Hourly rates corrected for atmospheric temperature and pressure from four cosmic-ray stations in Canada which have muon monitors maintained by AECL and from a survey monitor stationed at Kula, Hawaii, are given in tabular form by solar rotation for the period from the beginning of Rotation 1867 to the end of Rotation 1879 (January 17, 1970 to January 2, 1971). The Dorman– Maeda temperature correction factors for each station calculated at 12-hour intervals from the radiosonde data of the Canadian Meteorological Branch or the U.S. Weather Bureau are also listed. Barometric pressures are available from neutron monitor data reports already published. Graphs of the relative hourly rates at each station are given. (auth)

59399 (AECL–4209) COSMIC RAY IGY NEUTRON MONITOR DATA. III. From Deep River, Ontario and Monthly Graphs, January 1960–December 1960. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1972. 70p. Dep. NTIS (U. S. Sales Only). AECL $2.00.

Uncorrected and barometer-corrected hourly rates from Deep River are given in tabular form for the period from January 1960 to December 1960. The barometer-corrected data have been normalized to remove the effects of changes of efficiency and are compatible with the results of the 48-NM-64 monitor. Graphs of the corrected data are given. (auth)

59400 (AECL–4270) COSMIC RAY IGY NEUTRON MONITOR DATA. IV. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1972. 42p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

Uncorrected and barometer-corrected hourly rates from Deep River are given in tabular form for the period from January 1961 to December 1961. The barometer-corrected data were normalized to remove the effects of changes of efficiency and are compatible with the results of the 48-NM-64 monitor. Graphs of the corrected data are given. (auth) (Canada)

59401 (NP–19446) GAS PROPORTIONAL COUNTING OF ^{36}Cl IN IRON TARGETS AND IRON METEORITES. Cheng, Albert Shih-Cheang (State Univ. of New York, Stony Brook). Jul 1972. 105p.

Thesis.

^{36}Cl from targets and meteorites along with NaCl carrier was prepared as chloromethane gas and measured by gas proportional counting thereby increasing the sensitivity of ^{36}Cl analysis. In previous methods ^{36}Cl was counted as AgCl, NaCl, or NH_4Cl in an end-window counter or a screen-wall counter. The production cross sections for ^{36}Cl, ^{39}Ar, and ^{42}Ar of thin iron targets irradiated with 0.60, 3.0, and 29 GeV protons were measured. The cross sections for ^{36}Cl are 5.6 ± 0.18 mb, 6.3 ± 0.27 mb, and 5.6 ± 0.57 mb at 0.6 MeV, 3 GeV, and 27 GeV. The σ^{39}Ar/σ^{36}Cl ratios for these energies are 1.12 ± 0.038, 1.06 ± 0.53, and 1.07 ± 0.12, respectively. The ratio of $\mathring{A}^{39}$Ar/$\mathring{A}^{36}$Cl in iron phases of meteorites is 0.98 ± 0.05. Thus ($\mathring{A}^{39}$Ar/$\mathring{A}^{36}$Cl) meteorite/(σ^{39}Ar/σ^{36}Cl) target = 0.92 ± 0.07. One concludes that the present day cosmic-ray intensity is 0.92 ± 0.07 times the average cosmic-ray intensity during the last one million years. ^{36}Cl activity of samples from 3 different depths in the El Taco meteorite are 1.04 ± 0.07 dpm/kg, 0.45 ± 0.05 dmp/kg, and 0.12 ± 0.02 dmp/kg. The ^{36}Ar concentrations in these samples are 4.3×10^{-10} cc/g, 1.5×10^{-10} cc/g, and 0.53×10^{-10} cc/g. The exposure ages, therefore, are $(17.2 \pm 2.1) \times 10^6$ years, $(14.2 \pm 2.2) \times 10^6$ years, and $(19.4 \pm 5.5) \times 10^6$ years. These exposure ages are consistent within experimental error. From the distribution of ^{36}Cl in the El Taco meteorite, the three samples studied are estimated to have been located 54 cm, 68 cm, and 88 cm from the meteoroid surface.(auth)

59402 (NP–19466) COSMIC RAY 27-DAY RECURRENCES DURING 1965–69. Report No. 42. Aksland, A. M.; Amundsen, R. (Bergen Univ. (Norway). Dept. of Physics). Jun 1972. 26p. Dep. NTIS (U. S. Sales Only).

The 27-day variation in neutron-monitor data was analyzed according to three methods of analysis, autocorrelation, Chree, and power spectrum analysis. The years 1965–69 were investigated, i.e., the period from minimum to maximum activity in solar cycle No. 20. The periodic length of the 27-day recurrences was found to decrease from 31.5 days during start of cycle to 27.5 days towards maximum of activity. The most persistent recurrences occurred during 1967–68. The amplitude was found to vary with the level of solar activity; it was lowest during start of new cycle and increased with increasing activity towards a limit reached in 1966. The amplitude was kept roughly at this value for 3½ years onwards, while the solar activity steadily increased, and indicated a saturation of the modulation. The cosmic-ray 27-day recurrences were compared with corresponding variations found in solar wind speed, interplanetary field direction, photospheric field and coronal line (λ5303) intensity, and phase relations with geomagnetic activity and solar activity are discussed. The dependence of the modulation on the rigidity p could roughly be approximated by the form p^{-a}, with a ~ 0.4 to 0.7. (auth)

59403 ULTRA-HIGH-ENERGY COSMIC RAYS AND POSSIBLE GENERALIZATION OF THE RELATIVISTIC THEORY. Kirzhnits, D. A.; Chechin, V. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 15: No. 5, 1051-9(May 1972). (In Russian).

A possibility of attributing the absence of an ultra-high-energy cosmic ray spectrum cutoff to the breaking of usual relativistic theory at velocities close to the light velocity is considered. The usual relativistic theory is shown to admit a generalization being consistent with the principal postulate of the special relativity. Unlike the usual scheme the momentum space of the proposed model is anisotropic or in the other words the pseudoeuclidian space is replaced by the Finsler space. To explain the spectrum cutoff one must choose the undimensional parameter that characterizes the deflection from the usual theory of the order of 10^{-44} that is close to the value of the quantum gravitation theory interaction constant. (auth)

59404 ADIABATIC PROPAGATION OF COSMIC RAYS IN THE GALAXY. Barrowes, Steven C. (Louisiana State Univ., Baton Rouge). Astrophys. J.; 177: No. 1, 45-57(1 Oct 1972).

An analysis is presented for the propagation of charged cosmic rays away from a source in a relatively smooth galactic magnetic field. The expected intensity of the resulting narrow-angle anisotropy is related to the particle flux produced by the source. The probable number of such anisotropies is derived, based on the lifetime of cosmic rays and the number of sources in the Galaxy. The agreement with experimental evidence and future possibilities of the model are discussed. (auth)

59405 POLARIZATION OF EXTENSIVE AIR SHOWER EMISSION AT 6 MHz. Felgate, D. G. (Univ. of Lancaster, Eng.); Stubbs, T. J. Nature (London); 239: No. 5368, 151-2 (15 Sep 1972).

Some polarization measurements are described that were made with the Buckland Park aerial array of the University of Adelaide and the results are discussed in connection with the geomagnetic mechanism of origin and radio field strength. Comparisons are made with the results of other workers. (UK)

59406 METEOR VARIATION OF COSMIC-RAY INTENSITY FOR METEOR SHOWERS OF TYPES I AND II. Bel'skii, S. A. (Physical-Technical Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 1, 94-6(1972).

An investigation was made to explain the meteor effect in cosmic rays. Meteor showers, which the interplanetary field is directed along or across the orbit of the shower, were divided into types I and II respectively (epochs No. 1, 5, 6, 10, and 11). Two periods when a meteor effect was observed in an increase in cosmic-ray intensity were selected for analysis. The first, 1958–1959, was a period when solar activity began to decrease. For this period, the average effects at Sulfur Mt., Thule, Ottawa, and Mawson were used. The second period, September 1967 to September 1968, preceded the solar activity maximum. The average effects at Sulfur Mt. and Goose Bay were used. The neutron component of cosmic rays was analyzed by the superposition of epochs method and the dates of the maximum meteor shower effect were taken as zero days. The results show that a meteor-produced increase in cosmic-ray intensity was observed in both periods for both types of showers. The meteor effect is shown in a sharp increase in cosmic-ray intensity lasting about 15 days with a maximum on the zeroth day when intensity is maximal. (J.C.W.)

59407 CHARACTERISTICS OF COSMIC-RAY DIFFUSION IN A RADIALLY DIVERGING FLUX OF MAGNETIC INHOMOGENEITIES. Belov, A. V.; Dorman, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 1, 93-4(1972).

Translated from Geomagn. Aeron.; 12: No. 1, 113(1972).

Several diffusion models of cosmic-ray modulation are based on the hypothesis of scattering centers, which are magnetic inhomogeneities that are frozen into the interplanetary plasma and move radially away from the Sun with the solar wind. It is assumed that at some given distance from the Sun, the scattering centers have an isotropic distribution. The parameters are given for the distribution of the inhomogeneities to remain isotropic in a single plane: that perpendicular to the radius. An investigation is made of whether the anisotropic distribution of the scattering centers will lead to anisotropic diffusion. Formulation is presented to verify the spatial structure in the distribution of inhomogeneities. It is assumed that each scattering event is isotropic and all the inhomogeneities have the same dimension. It is shown that in the absence of the regular magnetic field diffusion remains isotropic despite the anisotropic distribution of scattering centers. Then, an analysis is made including a large-scale magnetic field. Thus, an additional radial dependence of the diffusion coefficient appears in the presence of a regular magnetic field in interplanetary space; it is associated with the diverging motion of scattering centers. (J.C.W.)

59408 DISTORTION OF THE STELLAR ANISOTROPY OF GALACTIC COSMIC RAYS BY THE SOLAR WIND. Belov, A. V.; Dorman, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 1, 91-2(1972).

Translated from Geomagn. Aeron.; 12: No. 1, 111-12(1972).

Distortion of the stellar anisotropy of galactic cosmic rays by the solar wind can have different causes, such as the uneven distribution of cosmic-ray sources in the galaxy, the presence near the Sun of regular galactic fields, the movement of the Sun relative to the interstellar medium, the uneven distribution of the electric gradient along solar latitude, association with the movement of the regular magnetic fields of the solar wind, etc. The last two factors are associated with the existence and activity of the Sun. All the causes listed may produce an uneven density distribution of galactic particles along the boundary of the modulation region and should not be excluded from analysis. The equations describing the distortion of stellar anisotropy by the solar wind are examined. (J.C.W.)

59409 COSMOGENIC RADIONUCLIDES IN THE ALLENDE AND MURCHISON CARBONACEOUS CHONDRITES. Cressy, Philip J. Jr. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 26, 4905-11(10 Sep 1972).

Measurements were made of ^{22}Na, ^{26}Al, ^{54}Mn, and ^{60}Co produced by cosmic rays in five samples of the Allende C3 meteorite and in one specimen of Murchison (C2); ^{46}Sc, ^{48}V, ^{51}Cr, and ^{57}Co were also measured in several of these samples. Comparison of observed Allende ^{60}Co activities with calculated neutron-capture production rates yields a depth scale for Allende that appears unambiguous to about 30-cm depth. Using this scale, the production of ^{26}Al is constant (±10%) to a depth in excess of 30 cm, ^{22}Na activity increases ~30% from near the surface of Allende to from 20- to 30-cm depth, and ^{54}Mn production increases ~50% over the same depth range. The ^{46}Sc/^{54}Mn activity ratio is constant at 0.059 ± 0.005 from 8 to 20 cm. Murchison's ^{26}Al activity yields a cosmic-ray-exposure age of 1.5×10^6 years. (auth)

59410 ALTITUDE DEPENDENCE OF THE ATMOSPHERIC X RAYS IN THE ENERGY RANGE 0.1 TO 1 MeV. Danjo, Atsunori (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 33: No. 4, 890-7(Oct 1972).

It is pointed out that balloon observations so far reported on the finite flux of diffuse cosmic x rays with energies greater than 0.2 MeV are subject to the procedure of subtracting the contribution of atmospheric x rays. The transport of photons generated in the atmosphere was followed by a Monte Carlo calculation. It is found that energy-degraded photons generated at greater depths cause a build-up effect and flatten the intensity vs depth relation, the growth curve, of omnidirectional atmospheric x rays at depths smaller than 10 gcm^{-2}. The present calculation can explain the behavior of the observed growth curves. Thus, it is concluded that the assumption, adopted in some of the reports, that the growth curve is represented by a power function of the atmospheric depth is not valid. The present result demonstrates that the observations thus far have given only an upper limit of the cosmic x-ray flux above 0.2 MeV. (auth)

59411 STUDY OF THE VESTIGIAL RECORDS OF COSMIC RAYS IN LUNAR ROCKS USING A THICK SECTION TECHNIQUE. Bhandari, N.; Goswami, J. N.; Lal, D.; Macdougall, D.; Tamhane, A. S. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A; 76: No. 1, 27-50(Jul 1972).

An experimental technique has been developed for systematic measurements of fossil tracks along selected planes cut from grains and rocks. With controlled etching, the technique allows successive revelation of tracks in different minerals in the same section, a typical sequence being olivine, anorthite, clinopyroxene. It thus becomes possible to study precisely the cosmic-ray track density variations over dimensions much greater than those of individual crystals. The technique also provides accurate information on the relative recording characteristics of different minerals present in a rock and cosmic-ray tracks can be studied with a minimum interference of tracks due to spontaneous fission of uranium and transuranic elements. (auth)

59412 PRIMARY COSMIC RAY NUCLEON SPECTRUM FROM SEA-LEVEL MUON SPECTRUM AND SCALING HYPOTHESIS PARAMETERS. Ramana Murthy, P. V.; Subramanian, A. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A; 76: No. 1, 1-12(Jul 1972).

Based on the measured sea-level muon energy spectrum and the fitted parameters of Feynman's scaling hypothesis that describe high-energy collisions, the primary cosmic-ray nucleon spectrum in the energy range 50 GeV < E < 5000 GeV was deduced. It is shown that the statistical errors in the resulting nucleon spectrum are among the lowest that exist now and any residual systematic uncertainties in the evaluated flux can be reduced further by using accurate high-energy collision data of nucleons and pions in light nuclei at current accelerator energies. (auth)

Stars

Refer also to abstracts 59996, 59997, and 60000.

59413 PHYSICAL STATE OF MATTER IN THE INTERIOR OF STARS. II. Nemeth, Judit (Lorand Eotvoes Univ., Budapest). Fiz. Szemle; 22: No. 5, 135-40(May 1972). (In Hungarian).

The virial principle is used to analyze the development of stars, finding that the thermal energy of the system increases at the expense of the gravitational energy. No energy is generated by nuclear means during the initial stages and the energy equilibrium is based on the replacement of the radiant energy with that released by gravitational contraction. The absolute value of the potential energy increases as the star contracts. A correlation is given between gravitational contraction and the increase of temperature and density, until a high central density creates a degenerate state. The last stage is that of the white dwarf. The temperature and mass conditions required for rendering various nuclear reactions possible, e.g., the burning of hydrogen, helium, carbon, and oxygen, are outlined. The intrastellar relations are examined on the basis of simplified models, such as the linear model, the polytropic star, the standard model, and the uniform energy distribution model. The stable state is examined, deriving a correlation between temperature and luminosity under consideration of the radiation—mass relation. The nuclear reactions, initiated by the contraction-induced temperature increase, follow a sequence determined by the consumption rate of the available nuclear fuels. (TTT)

59414 INDIVIDUAL REDDENING LAWS FROM O TYPE STARS. I. COMPUTATION METHOD, FIRST RESULTS. Goy, G. (Observatoire de Geneve, Sauverny, Switzerland). Astron. Astrophys.; 21: No. 1, 11-23(Oct 1972).

The individual interstellar extinction laws were obtained by means of the Geneva 7-color photometry. In view of insuring good precision in the determination of the parameters, the sample was restricted to O type stars. The reddening law is obtained by simulation. (W.D.M.)

59415 NEW ORBIT AND MASS OF THE VISUAL BINARY AND MAGNETIC Ap STAR ADS 7334 = HR 3724. van Dessel, E. L. (Royal Observatory, Brussels). Astron. Astrophys.; 21: No. 1, 155-7(Oct 1972).

The orbital elements, physical characteristics, and ephemeris of the visual binary ADS 7334 were calculated. A previous orbit of this star, computed by Finsen (1968), is shown to be unsatisfactory. The present orbit is in better agreement with spectroscopic observations by van den Heuvel (1971) and leads to plausible masses. (auth)

59416 Hα PROFILES FOR G-TYPE DWARFS AND SUBGIANTS. Hearnshaw, J. B.; Schmidt, Edward G. (Australian National Univ., Canberra). Astron. Astrophys.; 21: No. 1, 111-17 (Oct 1972).

The Hα wing profiles were computed from model atmospheres for G-type dwarfs and subgiants of various compositions. The profiles were insensitive to gravity and to helium abundance, but quite sensitive to metal abundance in addition to effective temperature. The metal abundance variation was in the sense that metal-poor stars have stronger Hα lines than normal composition stars of the same temperature. However, a study of the observed profiles in eighteen stars whose metal abundances were also measured, showed that the observed sensitivity of the Hα wings to metal abundance was somewhat greater than that predicted by the models. (auth)

59417 LUMINOSITY VARIATION IN THE ONE-ZONE CEPHEID MODEL. Stellingwerf, R. F. (Univ. of Colorado, Boulder). Astron. Astrophys.; 21: No. 1, 91-6(Oct 1972).

The one-zone stellar pulsation model is proposed as a tool to investigate the factors affecting luminosity variations of pulsating stars. The model is reformulated in dimensionless quantities with the parameters Q, the pulsation constant; ζ, the nonadiabaticity in the driving region; and Γ_1, the adiabatic exponent in the ionization zone. Linear and nonlinear analyses of the resulting equations are described. The results are in very good agreement with observations and do not include doubtful features which are present in many detailed calculations. (auth)

59418 RESONANCE EFFECTS IN POLYTROPES. Simon, N. R.; Sastri, V. K. (Univ. of Nebraska, Lincoln). Astron. Astrophys.; 21: No. 1, 39-44(Oct 1972).

Second-order anharmonic pulsational amplitudes were investigated for a variety of polytropic models. It was found that the qualitative behavior of these amplitudes is decisively affected by the existence of resonances—this remaining true even when a given model is itself not in a resonant situation. An empirical asymptotic formula is given for the normal mode spectra of polytropes. The question of resonances is discussed for real stars, and a suggestion made for classifying Cepheid-type pulsators on the basis of resonant properties. Invalid numerical results from an earlier work (Simon, 1971) are corrected in the Appendix. (auth)

59419 ITERATIVE NONLINEAR PULSATIONS IN MASSIVE STARS. I. THE ITERATIVE APPROACH. Simon, N. R. (Univ. of Nebraska, Lincoln). Astron. Astrophys.; 21: No. 1, 45-9(Oct 1972).

''Soft'' pulsations in a massive main-sequence star are considered and the regime in which the motion is nonlinear but not strongly so is investigated. The star is assumed to begin its finite amplitude pulsation in the linear fundamental mode. The adiabatic equation of motion is expanded (schematically) to third order in the radial amplitude, and a solution sought in the form of a Fourier series over an interval which turns out not to deviate much from the fundamental period of pulsation. Arguments based on the size of successive terms are used to isolate a set of five equations, the iterative solution of which should provide a complete and consistent description of weakly nonlinear adiabatic pulsations to the order required. It is shown that the existence of resonances does not pose any a priori objection to the iterative technique. (auth)

59420 INTERATIVE NONLINEAR PULSATIONS IN MASSIVE STARS. II. TERMS UP TO SECOND ORDER. Simon, N. R. (Univ. of Nebraska, Lincoln). Astron. Astrophys.; 21: No. 1, 51-5(Oct 1972).

An iterative technique was used to calculate radial adiabatic pulsational amplitudes up to second-order in a very massive main-sequence star. The second-order terms are displayed, and discussed in detail. A possible connection between the qualitative structure of these terms and the absence of observed massive main-squence pulsators is suggested. The resonance properties of the present model are discussed and their effect on the iterative calculation is considered. (auth)

59421 INFLUENCE OF ULTRAVIOLET LINE BLANKETING ON THE NEUTRAL HELIUM TRIPLET LINES IN B-TYPE STARS. Simpson, R. W.; O'Mara, B. J.; Hearn, A. G. (Univ. of Queensland, Brisbane). Astron. Astrophys.; 21: No. 1, 57-60(Oct 1972).

Recent calculations including departures from local thermodynamic equilibrium on the lines of neutral helium agree well with the observed singlet and triplet lines in O-type stars, but there are significant differences between theory and observation for the triplet lines in BO-type stars. Calculations show that the inclusion of line blanketing of the ultraviolet radiation field between 913 Å and 1500 Å in the calculation of the photoionization rates significantly improves the agreement between observed and calculated triplet line profiles in BO-type stars. Since line blanketing is more important in the cooler B-type stars, this suggests that the ultraviolet line blanketing is important in the formation of the neutral helium triplet lines in these stars. (auth)

59422 ORBIT, MASS RATIO, AND PARALLAX OF THE VISUAL BINARY ROSS 614. Lippincott, Sarah Lee; Hershey, John L. (Swarthmore Coll., Pa.). Astron. J.; 77: No. 8, 679-83(Oct 1972).

Photographs taken from 1938 to 1972 with the Sproul 24-inch refractor yield a definitive photocentric orbit for Ross 614 AB: $P = 16.60y$, $T = 1949.52$, $e = 0.38$, $\alpha = 0.312''$. The absolute parallax for the system is $\pi_{abs} = +0.248 \pm 0.003''$ (p.e.). Adopting $0.91 \pm 0.04''$ for the semiaxis major a of the relative orbit, the sum of the masses is $0.176 \pm 0.025_{\odot}$. With the adoption of Δm_{vis} as 3.5, $M_A = 0.114_{\odot}$ and $M_{AB} = 0.062_{\odot}$. Astrometric photometry on infrared sensitive plates yields $\Delta m_I = 2.1$ at $\sim\lambda 8000$. (auth)

59423 U, B, V PHOTOELECTRIC INVESTIGATION OF THE ECLIPSING-BINARY SYSTEM V505 SAGITTARII. Chambliss, Carlson R. (Kutztown State Coll., Pa.). Astron. J.; 77: No. 8, 672-9(Oct 1972).

The Algol-type eclipsing-binary system V505 Sgr was observed at Cerro Tololo during July and August of 1969. Approximately 470 observations each were obtained in U, B, and V. The period of V505 Sgr is 1.18287d, but during the last 40 years it has decreased by about 0.49s at a roughly uniform rate. V505 Sgr consists of an A2V primary component and a subgiant secondary, whose intrinsic spectral type is about G6-81V. Although very different in spectral type, the two components are almost identical in size. Hence the distinction between occultation and transit in such a system becomes purely formal in nature. It is found that a consistent set of geometrical orbital elements will satisfy all light curves. The orbital elements determined are in good agreement with those determined in previous studies of this system. Using the available spectroscopic data for V505 Sgr, the masses of the components are estimated as 2.19 $M_{\odot}$ and 1.18 $M_{\odot}$ and their respective radii as 2.18 $R_{\odot}$ and 2.20 $R_{\odot}$. V505 Sgr is a semidetached eclipsing-binary system. The hotter component is situated well inside its Roche lobe, while the cooler subgiant component fills, or very nearly fills, its own Roche lobe. The absolute visual magnitude of the system is estimated as +1.10 and the distance as 120 pc. (auth)

59424 SPECTRA OF UPGREN'S UNCLASSIFIED STARS. Sturch, C. R.; Sharpless, S. (Univ. of Rochester, N. Y.). Astron. J.; 77: No. 8, 669-71(Oct 1972).

Moderate dispersion spectra of Upgren's G5–G7 unclassified stars indicate that most are evolved for $B \leq 10.2$, but that a majority may be dwarfs in the next half-magnitude interval. When combined with densities of the other Upgren stars, these data suggest a doubling of G-dwarf space density beyond $z \sim 80$ pc. The abnormal distribution of transverse velocities reported earlier may result from assigning a single luminosity to all unclassified stars, but the abnormal colors are not fully explained. (auth)

59425 PHOTOELECTRIC OBSERVATIONS OF MAGNETIC STARS. IV. 41 TAU AND 21 COM. Blanco, C.; Catalano, F. A. (Catania Univ., Italy). Astron. J.; 77: No. 8, 666-8(Oct 1972).

Photoelectric observations in three colors of the magnetic stars 41 Tau and 21 Com are reported. For both stars improved periods are obtained. The oblique-rotator model seems to be the most reliable for 41 Tau. (auth)

59426 PHOTOMETRIC OBSERVATIONS OF THE STAR CLUSTER NGC 2141. Burkhead, Martin S.; Burgess, Roger D.; Haisch, Bernard M. (Indiana Univ., Bloomington). Astron. J.; 77: No. 8, 661-5(Oct 1972).

Photoelectric and photographic observations are presented for the open cluster NGC 2141. The data indicate the cluster is of late intermediate age with a main-sequence turnoff at $M_v = 3.5$, $(B-V) = 0.40$. A mean color excess of $E_{(B-V)} = 0.30$ and a distance modulus of $m-M = 14.1$ yield $(R = 3.0)$ a distance of 4.4 kpc. (auth)

59427 SOLUTION TO THE RADIATIVE BLAST WAVE IN STELLAR INTERIORS. Ojha, S. N. (Univ. of Gorakhpur, India). Acta Phys. Acad. Sci. Hung.; 31: No. 4, 375-83(1972).

The equations for the propagation of a symmetrically expanding spherical blast wave produced by a sudden explosion in a self-gravitating body, such as a star, are discussed taking into account radiation effects. The medium is assumed to be a perfectly conducting plasma with radiative parameters independent of the magnetic field. (L.T.W.)

59428 STRUCTURE AND CRITERIA ASSOCIATED WITH GRAVITATIONAL COLLAPSE OF POLYTROPIC SPHERES WITH NEGATIVE INDICES. Viala, Yves-Paul (Observatoire de Paris, Meudon, France). Compt. Rend., Ser. B; 275: No. 2, 117-20(10 Jul 1972). (In French).

The structure of a polytropic sphere of index n $(n < -1)$ is determined. The results are used to calculate the critical masses associated with the gravitational collapse of such spheres under an external pressure. (France)

59429 MASSES AND MAGNETIC FIELDS OF NEUTRON STARS. Greenstein, George (Amherst Coll., Mass.). Astrophys. J.; 177: No. 1, 251-3(1 Oct 1972).

Unless the mass of a pulsar is known beforehand, timing observations are able to determine its magnetic field only to within a range of 3–4 decades. Either this field is correlated with mass or both the field and the mass are constrained to lie within relatively narrow limits. (auth)

59430 PHOTOMETRY AND DIFFERENTIAL CORRECTIONS ANALYSIS OF ALGOL. Wilson, Robert E. (Univ. of South Florida, Tampa); De Luccia, Marie R.; Johnston, Kenneth; Mango, Stephen A. Astrophys. J.; 177: No. 1, 191-208(1 Oct 1972).

Two narrow-band light curves of Algol, at $\lambda\lambda$5500 and 4350, and one broad-band (λ5500) light curve are presented, along with their transformations to the B, V system. The comparison star, π Per, is considerably closer than those used for earlier complete light curves. Two times of primary minima were determined accurately, while five others were estimated from segments of primary eclipse. Some parts of a convenient scheme for computing the reflection effect, which were omitted in an earlier paper by Wilson and Devinney, are given. Those parameters of the Wilson—Devinney model which can realistically be determined for Algol were adjusted by differential corrections simultaneously for the three new light curves and for the 1.6-μ infrared light curve by Chen and Reuning. T_{eff} for the secondary component is about 5000°K, corresponding to a spectral type of about K1. The bolometric albedo of the secondary component was found to be 0.52 ± 0.02 p.e., in good agreement with Rucinski's theoretical estimate of 0.4 to 0.5. However, it seems that the presently available photometry does not permit a meaningful determination of the gravity-darkening parameter for the secondary, since this component has a very small fraction of the total system luminosity. (auth)

59431 RAPID CHANGES IN THE NEW SHELL STAR HR 6000. Bessell, M. S.; Eggen, O. J. (Australian National Univ., Canberra). Astrophys. J.; 177: No. 1, 209-17(1 Oct 1972).

Large quasi-periodic variations in color and brightness have been found for HR 6000 which is also a shell star with bright Hα. Analysis of the light and polarization changes suggests that the variations are caused by obscuration due to circumstellar dust clouds. The relative position in the color-magnitude diagram of HR 6000 and its companion HR 5999 indicates that HR 6000 may have evolved prematurely. (auth)

59432 ROCKET-ULTRAVIOLET SPECTRA OF EIGHT STARS IN OPHIUCHUS AND SCORPIUS. Morton, Donald C.; Jenkins, Edward B.; Matilsky, Terry A.; York, Donald G. (Princeton Univ., N. J.). Astrophys. J.; 177: No. 1, 219-34(1 Oct 1972).

Rocket ultraviolet spectra longward of 1100 Å have been obtained for the O and B stars ζ Oph and β^1, δ, ν, π, σ, τ, and ω^1 Sco. Detailed discussions are given for ζ Oph (O9.5 V) and δ Sco (B0 V), for which resolutions of 0.5 and 0.6 Å, respectively, were achieved. Wavelengths, line identifications, and relative intensities are presented in the tables and figures. The strongest photospheric absorption lines are attributed to C II, C III, N III, Si III, Si IV, and S III with He II, N IV, N V, O IV, Al II, and Si II also possible. The interstellar Lα absorption line is the strongest feature in all the spectra except τ Sco which does not extend to 1216 Å. Several other interstellar absorption lines are present in the high-resolution spectra including C II, O I, Si II, and possibly C I and N I in δ Sco, and C II and O I in ζ Oph. The resonance lines of C IV and perhaps also N V in ζ Oph appear to be shifted to shorter wavelengths by -900 and -400 km s^{-1}, respectively, indicating that there may be mass flow from this star. Some lines in ζ Oph which cannot be attributed to interstellar absorption are remarkably narrow, corresponding to turbulent velocities $\lesssim$100 km s^{-1} or rotational velocities $\lesssim$130 km s^{-1} compared with values 2 or 3 times larger obtained from visual spectra. (auth)

59433 ROCKET-ULTRAVIOLET SPECTRA OF SIX STARS IN PERSEUS. Morton, Donald C.; Jenkins, Edward B.; Macy, William W. (Princeton Univ., N. J.). Astrophys. J.; 177: No. 1, 235-44(1 Oct 1972).

Spectra of the O and B stars ϵ, ζ, ξ, o, and 40 Per, and HD 24640 have been photographed between 1130 and 2300 Å with a pair of rocket-borne objective spectrographs. Photospheric lines of He II, C II, C III, C IV, N III, Ni IV, Si III, and Si IV and also possibly N V, O IV, Al II, and Al III have been identified in one or more of the stars. The interstellar Lα line was measured in ξ, o, and 40 Per, giving an average volume density of 1.7 ± 0.5 hydrogen atoms cm^{-3} in this direction. There appears to be an interstellar contribution to the C II λ1334.5 line in ζ Per, but otherwise the spectra are too noisy for conclusive detection of the usual ultraviolet interstellar lines of C II, N I, O I, and Si II. The C IV resonance doublet in ζ Per (B1 Ib) has a P Cygni profile with a shift of -900 km s^{-1} in the absorption line, though no such displacement was found in the Si IV pair. For ξ Per (O7.5) the resonance lines of N V, Si IV, and C IV all have P Cygni profiles with absorption shifts averaging -1840 km s^{-1}. Smaller velocities were measured for the absorption lines of C III λ1175.7 and N IV λ1718.5 which arise from excited levels. (auth)

59434 OBSERVATIONS OF CARBON MONOXIDE IN COOL STARS AT 4.7 MICRONS. Geballe, T. R. (Univ. of California, Berkeley); Wollman, E. R.; Rank, D. M. Astrophys. J.; 177: No. 1, L27-32(1 Oct 1972).

Spectra of six stars with high infrared luminosities have been obtained, with spectral resolution of 0.18 cm^{-1}, near the fundamental vibration-rotation band origin of $^{12}C^{16}O$ at 2140 cm^{-1}. They have been analyzed for rotational and vibrational temperatures, isotopic abundances, and column densities, the latter being in all cases substantially lower than theoretical predictions. For all six stars, the isotopic ratio $^{12}C/^{13}C$ is less than 10. The presence of $^{12}C^{18}O$ in W Hya, α Boo, and α Her is indicated. (auth)

59435 SHORT-TIMESCALE STRUCTURE IN TWO PULSARS. Hankins, T. H. (Univ. of California, San Diego). Astrophys. J.; 177: No. 1, L11-15(1 Oct 1972).

Frequency-independent characteristic timescales of 175 and 575 μs have been found, using a new predetection dispersion-removal technique, in the intensity structure of meter-wavelength radio signals from the pulsars CP 0950 and CP 1133. (auth)

59436 OBSERVATIONS OF RAPID BLUE VARIABLES. X. G61-29. Warner, B. (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc.; 159: No. 3, 315-19(1972).

Photoelectric observations of the helium-emission-line white dwarf G61-29 are presented. The presence of rapid flickering, occasionally with an amplitude ~0.20 mag on a time scale ~20 s, is established. The light curve contains features resembling that of the binary VV Pup, including effects which can be ascribed to an eclipse by the secondary and obscuration by an optically thick ring. A tentative orbital period of 6^h 16^m is determined for G61-29. It is suggested that G61-29 resembles the cataclysmic variables, but that helium rather than hydrogen is being transferred between the components of the binary system. Both components are therefore probably the helium cores of evolved stars. (auth)

59437 OBSERVATIONS OF RAPID BLUE VARIABLES. XI. DQ HERCULIS. Warner, Brian; Peters, William L.; Hubbard William B.; Nather, R. Edward (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc.; 159: No. 3, 321-35(1972).

A study was made of the phase, amplitude, and shape of the 71-s periodic light variations around several binary cycles of DQ Her. It is shown that, relative to the usually adopted period of 71.06550 s, there is a 360° phase shift through eclipse. The light curve is sinusoidal within observational error. The observed phase variations are difficult to explain except in terms of a grazing eclipse of a white dwarf pulsating in a nonradial quadrupole mode. (auth)

59438 SECOND CH STAR IN OMEGA CENTAURI AND THE $^{12}C/^{13}C$ RATIO. Dickens, R. J. (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Notic. Roy. Astron. Soc.; 159: No. 3, 7P-9P(1972).

A red giant in the globular cluster ω Cen, star No. 70 in the Herstmonceux catalog, shows carbon features and strong CN and CH bands. Its radial velocity indicates cluster membership. Both for this star and the previously known CH star, RGO No. 55, the absorption features around λ 4737 Å, which are presumed to be the main and isotopic C_2 bands, probably indicate a relatively high ^{13}C content. (auth)

59439 PHOTOMETRY AND SPECTROSCOPY OF RED VARIABLES IN OMEGA CENTAURI. Dickens, R. J.; Feast, M. W.; Evans, T. Lloyd (Radcliffe Observatory, Pretoria). Mon. Notic. Roy. Astron. Soc.; 159: No. 3, 337-48(1972).

Spectroscopy and infrared photographic photometry were carried out for a number of red variables in the globular cluster, ω Centauri (NGC 5139). V2 and V129 are nonmembers. V53, V152, V162, V138, V148, and V161 lie near the red giant tip of the $I_K/(V - I_K)$ diagram. Spectra of the first three show them to be radial velocity members with spectral types similar to those of nonvariable red giants in the cluster. V164, a radial velocity member with a similar spectrum, lies below the giant branch. V6, V17, and V42, all radial velocity members, have large $(V-I_K)$ colors and M-type spectra. They indicate an extension of the giant branch to cooler temperatures than previously associated with metal-poor clusters. RGO 4789 (membership uncertain) is also a red variable lying in the same region of the HR diagram. (auth)

59440 IONIZATION ZONES REMAINING AFTER SUPERNOVA EXPLOSIONS. Bisnovatyi-Kogan, G. S. (Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 368-9(1972).

Translated from Astron. Zh.; 49: No. 2, 453-4(1972).

It is shown that investigation of ionization zones left after supernova explosions can yield information on the mechanism active in those explosions. (auth)

59441 OBSERVATION OF VARIATION OF COLOR EXCESSES OF HOT STARS WITH TIME. Raznik, R. M. (Ulyanov State Pedagogical Inst., USSR). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 370-1(1972).

Translated from Astron. Zh.; 49: No. 2, 455-6(1972).

Systematic changes in the color excess $E_{(B-V)}$ of stars of spectral class O9.5 in the cluster NGC 6913 are noted. According to photoelectric observations by the author as compared with earlier data, the "blueing" of the stars amounts to 0.12 to 0.13 m over 13 years. (auth)

59442 ALPHA PERSEI CLUSTER. Artyukhina, N. M. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 317-23(1972).

Translated from Astron. Zh.; 49: No. 2, 389-96(1972).

From a proper-motion survey of the α Per cluster reported elsewhere, apparent- and space-density distribution curves are derived for possible cluster members brighter than 12 m pg as a function of distance from the cluster center. The cluster comprises a nucleus 1.25° (3.7 pc) in radius and a corona 2.5° (7.4 pc) in radius. It contains 83 members brighter than 11 m pg. The corona contains 25% of the members brighter than 10 m and 50% of those from 10 to 11 m pg. Within the cluster region ($r = 2.5°$) there are 136 field stars brighter than 12 m pg whose proper motions agree with the motion of the cluster (according to a 3σ criterion). Luminosity functions are derived for the nucleus and corona stars. (auth)

59443 MEAN ABSOLUTE MAGNITUDES AND COLOR INDICES OF THE RED-GIANT CONCENTRATIONS IN THE COLOR-MAGNITUDE DIAGRAMS OF OPEN CLUSTERS. Vasilevskii, A. E. (Gorky Ural State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 308-16(1972).

Translated from Astron. Zh.; 49: No. 2, 378-88(1972).

Relations for the mean absolute magnitude and mean color indices of the centers of the red-giant concentrations in open star clusters are determined as functions of the cluster age according to published photometric data. For this purpose the parameters of the zero-age main sequence and the distance moduli and ages of 32 clusters are redetermined by new methods. The relations obtained afford a reliable determination of the color excesses and distance moduli of open clusters rich in giants by means of two-color photometry. The small scatter in these relations suggests that open clusters tend to have the same chemical compositions. (auth)

59444 THEORY FOR THE STABILITY OF A STAR WITH TOROIDAL MAGNETIC FIELD. Vandakurov, Yu. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 265-72(1972).

Translated from Astron. Zh.; 49: No. 2, 324-33(1972).

Criteria are derived for the stability of adiabatic low-frequency nonradial oscillations of a gravitating configuration with an internal toroidal magnetic field. The magnetic pressure is assumed much less than the thermal pressure of the medium. Regions are considered that are almost neutrally stable against convection if magnetic forces are neglected. A necessary criterion for the case of an infinite cylinder, and its dependence on the parameters m and k specifying the number of nodes in azimuth and along the cylinder is investigated. A toroidal field will generally tend to destabilize nonaxisymmetric perturbations with $m = 1$ (the mode with maximum wavelength along the field lines). This result holds for a wide class of field distributions if the configuration is nearly spherically symmetric. For superdense stars whose internal pressure depends on density alone, the condition for neutral stability is automatically satisfied in the absence of a field, and any toroidal field can apparently induce instability if the growth time is shorter than the time for damping (such as by radiation of gravitational waves). (auth)

59445 NUCLEAR ENERGY SOURCES IN SUPERDENSE CELESTIAL BODIES. Avakyan, R. M.; Saakyan, G. S. (Erevan State Univ.). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 259-64(1972).

Translated from Astron. Zh.; 49: No. 2, 316-23(1972).

It is shown that the concept of superdense celestial bodies (white dwarfs and baryonic stars) as entities completely depleted of stores of internal energy falls short of an entirely adequate explanation. It appears that there are sufficient reserves of nuclear energy present in the interiors of white dwarfs and in the envelopes of baryonic stars (matter in the Ae-phase and Aen-phase) to account for the existence of those systems in a hot state for several billion years. In the case of white dwarfs, this energy store is entirely sufficient to account for their observed luminosity. (auth)

59446 NEUTRON-RICH NUCLEI IN A FERMI GAS. Vartanyan, Yu. L.; Ovakimova, N. K. Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 250-8(1972).

Translated from Astron. Zh.; 49: No. 2, 306-15(1972).

The equation of state is considered at subnuclear densities for which matter consists of atomic nuclei immersed in a degenerate electron—neutron gas. It is shown that with increasing density the existence of nuclei which are anomalously rich in neutrons becomes favored. With increasing density the binding energy of such nuclei decreases, and for a density $\rho = 2.5 \cdot 10^{13}$ g/cm^3, it is equal to zero. At higher densities the nuclei cannot exist, and the matter consists of a mixture of degenerate neutron, proton, and electron gases. (auth)

59447 TWO-QUANTUM PHOTON-PLASMON TRANSITION. Kaplan, S. A.; Kleiman, E. B.; Oiringel', I. M. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 241-3(1972).

Translated from Astron. Zh.; 49: No. 2, 294-7(1972).

The probabilities of two-quantum induced photon—plasmon $2S_{1/2}-1S_{1/2}$ transitions in a hydrogen atom are calculated and the conditions under which these transitions are more efficient than ordinary photon—photon emission are discussed. The role of these processes in nebulae and stellar chromospheres is also considered. (auth)

59448 STUDY OF THE SPECTRUM-VARIABLE SILICON Ap STAR 56 Ari. Aslanov, I. A.; Khokhlova, V. L. (Astronomical Council, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 224-9(1972).

Translated from Astron. Zh.; 49: No. 2, 271-8(1972).

A study of the profiles of Si II, He I, and hydrogen lines in the spectrum-variable silicon Ap star 56 Ari was carried out using 30 spectrograms obtained at the end of 1969 and beginning of 1970 with dispersions of 4, 10, and 14 Å/mm. The variations of radial velocities and of equivalent widths agree with the idea that the star's surface has five areas of enhanced silicon lines and three areas of enhanced helium lines. Estimates were made which show that, in the areas of maximum intensity of helium lines, the helium content is normal, while in the areas of minimum intensity these lines are deficient by a factor of ten. The number of hydrogen atoms in the second level, as determined from the W_λ of the hydrogen lines, varies with phase. The observed variations can be explained by temperature differences on the star's surface in agreement with the (U−B) variations. The possibility of variations in 56 Ari's spectrum with period differing from the rotational period is pointed out. (auth)

59449 NONSTATIONARY HYDRODYNAMICAL ACCRETION ONTO A NEUTRON STAR. Zel'dovich, Ya. B.; Ivanova, L. N.; Nadezhin, D. K. (Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 209-18(1972).

Translated from Astron. Zh.; 49: No. 2, 253-64(1972).

The nonstationary accretion of an optically thick gaseous cloud onto a neutron star is considered. The accretion of a cloud of small mass ($\sim 10^{-5}$ $M_\odot$) is computed numerically, taking into account the radiative thermal conduction and neutrino emission. The nonstationary phase of the accretion of such a cloud is followed by a stage of slow hydrostatic contraction. The characteristic contraction time is determined by the energy losses due to neutrino emission. The photon luminosity, which is equal to 10^4 $L_\odot$, is smaller than the neutrino luminosity by a factor of 10^7. It is shown that the accretion of a massive cloud (0.1 to 1 $M_\odot$), which may occur during supernovae outbursts and during the collision of a neutron star with an ordinary star, should, for the most part, be hydrodynamical. Almost all the gravitational energy of the cloud ($\sim 10^{52}$ ergs) is then emitted in the form of neutrinos of energy of several tens of MeV. (auth)

59450 ANALYSES OF LIGHT-ION SPECTRA IN STELLAR ATMOSPHERES. I. MAGNESIUM II IN B AND O STARS. Mihalas, Dimitri (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 177: No. 1, 115-28(1 Oct 1972).

A calculation of the spectrum of Mg II in B and O stars, using a rather complete model atom allowing for many explicitly calculated transitions in steady-state statistical equilibrium, has been performed. These computations give a good fit to the observed equivalent widths of the λ4481 line on the entire range from B5 through O6, assuming a solar abundance for magnesium. In contrast, for the earliest spectral types, the LTE predictions fit the data poorly, and are shown to yield abundances systematically in error by an order of magnitude or more. These results open again serious questions concerning the validity of LTE abundances for at least the O and early B stars, and suggest strongly that further analyses are needed to delineate the ions and spectra types for which the LTE assumption fails. (auth)

59451 SEARCH FOR DENSITY AND PRESSURE INVERSIONS IN HIGH-TEMPERATURE, LOW-GRAVITY MODEL ATMOSPHERES. Borra, Ermanno F.; Fortier, Louis (Univ. of Western Ontario, Can.). Astrophys. J.; 177: No. 1, 129-35(1 Oct 1972).

The existence of pressure and density inversions in high-temperature, low-gravity model atmospheres was investigated. None of the hot unblanketed models presented unstable layers. The findings therefore seem to question a proposed mechanism for energization of a stellar corona and mass loss in hot stars. Rapidly rotating early-type stars are found to have cool unstable layers. The extent of these layers is more important for less massive stars and increases with evolutionary age. (auth)

59452 20-MICRON FLUXES OF BRIGHT STELLAR STANDARDS. Simon, Theodore; Morrison, David; Cruikshank, Dale P. (Univ. of Hawaii, Honolulu). Astrophys. J.; 177: No. 1, L17-21 (1 Oct 1972).

Observations made at Mauna Kea Observatory between July 1971 and May 1972 establish relative fluxes in the 17 to 25-μ band. Based on an absolute flux for α Boo at 20 μ of 1.54×10^{-16} W cm^{-2} μ^{-1} ($m_{20} = -3.32$) derived from shorter-wavelength observations and from model atmospheres, 20-μ magnitudes are obtained for nonvariable standards as follows: α Tau, -3.21; α Ori, -5.67; β Gem, -1.24; and β Peg, -2.71. Preliminary data on eight other stars are also presented. (auth)

59453 CONTRIBUTION OF AUTOIONIZATION LINES TO STELLAR OPACITIES. Merts, A. L.; Magee, N. H. Jr. (Los Alamos Scientific Lab., N. Mex.). Astrophys. J.; 177: No. 1, 137-43(1 Oct 1972).

The opacity of a stellar mixture was calculated including autoionization lines. The results of this calculation indicated that the Rosseland mean opacity is increased by less than 5% in the temperature density range of interest for stellar interiors. (auth)

59454 THERMAL EQUILIBRIUM STATES OF A CLASSICAL SYSTEM WITH GRAVITATION. Aronson, Elliot B. (Univ. of Colorado, Boulder); Hansen, Carl J. Astrophys. J.; 177: No. 1, 145-53(1 Oct 1972).

A set of calculations is presented which describe the thermal equilibrium states of a classical hard-sphere gas contained in a spherical box where the coupling between local thermodynamics and gravitation is explicitly taken into account. It is found that, under certain conditions, structural transformations may take place which give rise to core–halo configurations. Comparisons are made between this and other models. The possible implications for the statistical mechanics of gravitating systems are considered. (auth)

59455 THERMAL INSTABILITY OF THE HYDROGEN-BURNING SHELL IN NONDEGENERATE STARS. Stothers, Richard; Chin, Chao-wen (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 177: No. 1, 155-60(1 Oct 1972).

An investigation was made of thermal instability in the hydrogen-burning shell of stars of moderate to high mass evolving from the end of core hydrogen burning to the early stages of core helium burning, with the help of an approximate analytic criterion for thermal instability and full nonlinear numerical calculations of stellar evolution. Two different assumptions about the chemical evolution in the stars of highest mass were adopted. Thermal pulses were found to develop only in very massive stars having convective intermediate zones, when the hydrogen profile in the shell was sufficiently steep and the shell was still moderately thick. (auth)

59456 STATISTICAL STUDIES IN STELLAR ROTATION. II. A METHOD OF ANALYZING ROTATIONAL COUPLING IN DOUBLE STARS AND AN INTRODUCTION TO ITS APPLICATIONS. Bernacca, P. L. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 177: No. 1, 161-75(1 Oct 1972).

The coupling between the rotational velocities v_1 and v_2 of the components of double stars has bearing on their origin, on the problem of synchronism, and on the distribution of angular momentum in dust and gas clouds. Since the observations give the apparent velocity $v_k \sin i_k$ ($k = 1, 2$), the only large-scale approach is statistical and it requires the knowledge of the probability density $\psi(i_1,i_2)$. The study of the bivariate distribution for a sample of visual binaries indicates that the regression $\bar{x}_2(x_1)$ is nearly a linear function with $\bar{x}_2(0) = 0.2$ and $\bar{x}_2(1) = 0.8$ and that the array probability density $H(x_2|x_1)$ is maximum for $x_1 = x_2$. A table of correspondence between v_1 and the average value of v_2 is given in the range BO–FO. The proposed method of analysis lends support to the existence of synchronism in closely spaced binaries. (auth)

59457 CIRCULAR POLARIMETRY OF FIFTEEN INTERESTING OBJECTS. Kemp, James C. (Univ. of Hawaii, Honolulu); Wolstencroft, Ramon D.; Swedlund, John B. Astrophys. J.; 177: No. 1, 177-89(1 Oct 1972).

A search is described for circular polarization of visible light in 15 objects: two eclipsing binaries (β Lyr and BM Ori); six magnetic Ap stars; three planetary nebulae; NGC 2261 (Hubble's Nebula); M87; Sirius; and the Orion A region. Broadly speaking, the results were null, down to typical upper limits for q of 0.01%. Marginal but probably real results were obtained for IC 2022, $q = +(0.070 \pm 0.025)\%$, presumably due to the central star; and for a region in the Ori A region, wherein $q = +(0.060 \pm 0.025)\%$ in the red. Of the Ap stars only HD 126515 and HD 215441 appear to warrant more work at the photon-collection rate of the 88-inch telescope; in the others, upper limits for broad-band circular polarization of 0.01% or less are reported. The paper also contains a complete description of the photoelastic polarimeter, with special attention to the incidental linear-circular conversion. (auth)

59458 REDUCED-PROPER-MOTION DIAGRAMS. II. LUYTEN'S WHITE-DWARF CATALOG. Jones, Eric M. (Los Alamos Scientific Lab., N. Mex.). Astrophys. J.; 177: No. 1, 245-50(1 Oct 1972).

Spectroscopic and photometric surveys by Eggen, Greenstein, and others have yielded almost no classical degenerates with Luyten color class redder than class g. Reduced-proper-motion diagrams made from Luyten's catalog and from a large number of photometrically observed objects show that Luyten's selection criterion will naturally yield a large proportion of subdwarfs and "Eggenites" among the red and yellow candidates. New selection criteria relating reduced proper motion and color class or B–V color index are proposed to distinguish classical degenerates from the mixed subdwarf-Eggenite sequences. (auth)

59459 LIGHT VARIATIONS OF XY BOOTIS AND LS HERCULIS. Binnendijk, L. (Univ. of Pennsylvania, Philadelphia). Astron. J.; 76: No. 9, 923-9(Nov 1971).

A total of 441 observations in yellow light and 440 observations in blue light are presented for the system XY Bootis. The period is variable and the light curve of this W UMa-type system shows partial eclipses which after rectification become very shallow. LS Herculis was observed during six consecutive nights. The period and the shape of the light curve change during this relatively short time interval. Reasons are given to indicate that LS Her is probably an RR Lyrae-type variable. (auth)

59460 POSSIBLE EXISTENCE OF DIFFERENT POPULATIONS IN THE DOUBLE CLUSTER H AND χ PERSEI. Galeotti, Piero; Silvestro, Giovanni, Trussoni, Edoardo. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 51: No. 3-4, 228-33 (1972).

The absolute motion of individual supergiants and the stellar content of the double clusters h and χ Persei were studied, taking into account new observational data on the radial velocities, proper motions, and distances. The probable existence of three different populations of supergiant stars is proposed. (L.T.W.)

59461 POLARIMETRY OF RED AND INFRARED STARS AT 1 TO 4 MICRONS. Dyck, H. M. (Kitt Peak National Observatory, Tucson, Ariz.); Forbes, F. F.; Shawl, S. J. Astron. J.; 76: No. 9, 901-15(Nov 1971).

Polarimetric data in the 1–4-μ spectral range are presented and discussed for 64 stars, mostly of late spectral type. It is shown that large polarization in the near infrared is usually associated with extreme circumstellar shell characteristics among the cool stars. Variable polarization in the near infrared has not yet been found which exceeds 1%, if it exists at all. Many previously unidentified infrared sources from the Caltech 2-μ survey have been found to be intrinsically polarized. Particular attention has been paid to VY CMa which has previously been shown to be peculiar polarimetrically by Forbes. We develop a qualitative model in which the circumstellar shell contains two discrete particle sizes, one of the order of 1 μ (radius) and the other of the order of 0.1 μ. For a hypothetical optically thin analog, it is demonstrated that all of the polarimetric features observed in VY CMa can be reproduced in an asymmetric circumstellar envelope containing spherical grains of (Mg, Fe) SiO$_3$. (auth)

59462 SUPERNOVAE DISCOVERED SINCE 1885. Kowal, Charles T.; Sargent, Wallace L. W. (California Inst. of Tech., Pasadena). Astron. J.; 76: No. 9, 756-64(Nov 1971).

Tables of the confirmed supernovae discovered from 1885 through May 1971 are given. (L.T.W.)

59463 NOVAE IN THE MAGELLANIC CLOUDS DURING THE 1970–1971 OBSERVING SEASON. Graham, J. A.; Araya, G. (Cerro Tololo Inter-American Observatory, La Serena, Chile). Astron. J.; 76: No. 9, 768-74(Nov 1971).

A new survey for Magellanic Cloud novae has been initiated at Cerro Tololo Inter-American Observatory. During the period 7 September 1970 to 30 March 1971, two novae were discovered in the Large Magellanic Cloud. The methods used for the survey are discussed. Two photographs identifying the two novae in the surrounding star fields are published. Some photometric observations of the decline of the two novae are also presented. (auth)

59464 POPULATION II STARS AND THE ELECTRON–NEUTRINO WEAK INTERACTION. Demarque, P.; Mengel, J. G. (Yale Univ., New Haven). Nature (London) Phys. Sci.; 239: No. 91, 55-6(25 Sep 1972).

Evidence is discussed for the existence of the electron–neutrino interaction based on the luminosity of horizontal-branch stars in globular clusters, together with an argument based on relative counts of red giants and horizontal-branch stars in these clusters. The findings appear to confirm the Feynman and Gell–Mann theory of weak interactions (Phys. Rev.; 109: 193(1958)). Methods of determining the luminosity of the horizontal branch stars from the observational data are described. (UK)

59465 π^- CONDENSATION AND NEUTRON STAR COOLING. Kogut, J.; Manassah, J. T. (Inst. of Advanced Study, Princeton, N. J.). Contract No. AT(11-1)-2220. Phys. Lett.; 41A: No. 2, 129-31(11 Sep 1972).

It is shown, within the context of an independent particle model, that π^- condensation should occur in neutron stars having baryon densities exceeding ~0.4 to 0.5 fm^{-3}. This high concentration of π^- implies a very fast cooling rate for "hot" neutron stars. (auth)

59466 BUCHAREST K S Z CATALOGUE OF FAINT STARS FOR 1950.0. DECLINATION ZONE -11° TO +11°. Bucharest; Publishing House of the Academy of the Socialist Republic of Romania (1972). 364p. Lei 31.

The observations for the K S Z Catalog of Faint Stars (3939 stars within the −11° to +11° declination zone) were made during the years from 1955 to 1963. (W.D.M.)

59467 MAGNETIC STARS. Pikel'ner, S. B.; Khokhlova, V. I. (State Astronomical Inst., Moscow). Usp. Fiz. Nauk; 107: No. 3, 389-404(Jul 1972). (In Russian).

A brief history of magnetic stars is given with reference to pulsars, white dwarfs, and spectral classes. Magnetic stars usually rotate more slowly than normal stars of the same class. A_P-stars, the anomalous chemical composition of the atmospheres of magnetic stars, and the possibility of anomalous nuclear reactions in the latter represent major topics of discussion. Diffusion separation of the elements may be aided by radiation pressure which may be different for different elements, but difficulties with the diffusion mechanism are met. The source of the magnetic field and the effects of anisotropic turbulence and gas compression are analyzed. (32 references) (K.S.W.)

59468 VECTOR PLASMA MODEL FOR SUPERDENSE MATTER AND SUPERLUMINAL SOUND PROPAGATION. Kalman, G. (Brandeis Univ., Waltham, Mass.); Lai, S. T. Ann. Phys. (N. Y.); 73: No. 1, 19-48(Sep 1972).

A model for an ultrahigh density system consisting of particles in a plasma-like state and interacting through a short range massive vector field is developed. The main concern is to see how correlation effects modify the sound speed, the equation of state and the stability of the plasma state, and in particular whether superluminal sound propagation can occur. Correlation effects are treated by means of fluctuation–dissipation approach and also by ring approximation of Ursell–Mayer cluster expansion. In the domain of the validity of the plasma approximation correlation contributions cannot substantially modify the combined kinetic and Hartree terms and the sound speed is subluminal. For high densities and strong coupling leading outside the plasma domain correlations can dominate, possible phase transitions are present and the sound speed exceeds c, the velocity of light in vacuo. At very high densities the Hartree energy becomes overwhelming and the sound speed approaches c asymptotically again. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 59534, 59536, and 60042.

59469 FORMALDEHYDE ABSORPTION ASSOCIATED WITH W44. Whiteoak, J. B.; Gardner, F. F. (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 21: No. 1, 159-61(Oct 1972).

An investigation with a beamwidth of 4.2′ has shown that the +43 km/s CH_2O absorption over W 44 arises in a cloud that a) is centered in direction near the edge of the continuum distribution, b) has halfwidths of 7 × 4′, and c) has a peak optical depth of 0.85. The location and velocity are similar to those of the previously-observed OH absorption and emission which are believed to be associated with the supernova remnant, although the OH cloud is considerably larger. In the CH_2O cloud, the ratio of optical depths $\tau(CH_2O)/\tau(OH)$ exceeds 3, while for the +12 km/s absorption that occurs well away from the source the ratio is 0.5. (auth)

59470 TRANSFER EFFECTS ON X-RAY LINES IN OPTICALLY THICK CELESTIAL SOURCES. Felten, James E. (Univ. of Arizona, Tucson); Rees, Martin J.; Adams, Thomas F. Astron. Astrophys.; 21: No. 1, 139-50(Oct 1972).

The expected strengths of characteristic x-ray lines emitted by a thermal plasma cloud are altered when the cloud is sufficiently large and dense. Photoionization drives the ionization equilibrium toward higher states, affecting the line emissivities. Thomson scattering removes photons from the line cores; in resonance lines this effect is enhanced by resonance scattering, which increases the path length required for escape from the medium. Uniform static isothermal spherical models of Sco X–1 are considered, having temperatures $T = 5$, 7, and 10×10^7°K, and Thomson-scattering optical thicknesses along a radius $\tau_{es} = 5$, 10, and 20. Expected fluxes ϕ and equivalent widths w in line cores and in the total lines (including the wings) are calculated approximately for several lines of sulfur and iron. "Cosmic" abundances are assumed. The density of ionizing photons in the source is obtained by diffusion theory. Collisional transitions are taken into account in determining the line emissivities. The effects of Thomson and resonance scattering are estimated by an approximate skin-depth method involving functions given by Hummer and Rybicki. In these source models the line wings are too broad (several keV) for easy observation, though the expected flux in the wings of Fe^{+25} Lyman alpha is consistent with a report of detection by the Lockheed group. The predicted cores (actual width ~ few eV) are weak; e.g., S^{+15} $L\alpha$ has $w_c < 1$ eV. $L\alpha$ lines of lighter hydrogenic ions and the Fe^{+25} $L\alpha$ and Fe^{+24} $2^1P \rightarrow 1^1S$ lines all have $w_c \lesssim 3$ eV. The nonresonance intercombination ($2^3P \rightarrow 1^1S$) and forbidden ($2^2S \rightarrow 1^1S$) lines of Fe^{+24} are more promising; their combined w_c ranges from 0.2 up to 34 eV in these models. The $2^3P \rightarrow 1^1S$ line should be the stronger. Nonsphericity, bulk motions, and other changes in the models would allow stronger lines cores. The present observational upper limit on the Fe^{+24} line cores is $w_c < 25$ eV. (auth)

59471 LOW ENERGY X-RAY SURVEY FROM THE CRAB NEBULAR TO CYGNUS. Garmire, G.; Riegler, G. R. (California Inst. of Tech., Pasadena). Astron. Astrophys.; 21: No. 1, 131-8(Oct 1972).

Observations of cosmic x rays in the energy band 0.2 to 3.0 keV were made from an experiment on board on Aerobee 170 rocket launched from White Sands N. M. on December 19, 1970 at 03h 10m2.1s UT. A survey along the galactic plane between the Crab Nebula and Cygnus provided data on the interstellar absorption and x-ray flux for the Crab Nebula, NP 0532, Cas A, Cyg X–2, and upper limits to the flux from a number of supernova remnants. The 0.25 keV x-ray background was measured over a limited range of galactic latitude and longitude. (auth)

59472 FURTHER HIGH-RESOLUTION SEARCH FOR Fe XXV LINE EMISSION FROM SCORPIUS X-I. Griffiths, R. E. (Univ. of Leicester, Eng.). Astron. Astrophys.; 21: No. 1, 97-103(Oct 1972).

An improved LiF crystal spectrometer was flown on a sounding rocket to search for emission lines from the helium-like ion Fe XXV in Sco X–1. A 3σ upper limit of 25 eV is set on the E.W. of narrow line emission from this ion, when the overall x-ray spectrum indicated a source temperature of 55×10^6°K. Assuming that the lines are not substantially broadened by mass motion of an orbiting plasma, this result is shown to be consistent with values of the electron scattering optical depth obtained from infrared and optical studies of Sco X–1. From proportional counters on the same rocket experiment, a 5σ upper limit of 100 eV was set on the total Fe XXV-XXVI line emission. This result is discussed and compared with those of similar proportional counter experiments on Sco–1. (auth)

59473 ACCRETION DISC MODELS FOR COMPACT X-RAY SOURCES. Pringle, J. E.; Rees, M. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astron. Astrophys.; 21: No. 1, 1-9(Oct 1972).

The accretion process is considered, in cases when the infalling matter possesses angular momentum and forms a disc spinning around a central compact mass. This situation occurs when gas falls onto a black hole or neutron star from a binary companion, and may be relevant to galactic x-ray sources. The spectrum of the radiation emitted by gas spiralling down into a black hole is calculated and compared with the data on Cygnus X-1. Rapid irregular variability is expected in this model. If the compact object is a neutron star, the gas dynamics near the star may be controlled by the stellar magnetic field. The main x-ray emission then comes not from the disc, but from regions on the stellar surface near the magnetic poles. An interpretation of Centaurus X-3 involving a rotating magnetized neutron star is proposed. It is emphasized that accretion discs can display a wide range of properties (depending on the accretion rate, viscosity, etc.). Tentative interpretation of some other phenomena is also proposed. (auth)

59474 OBSERVATIONS OF THE INTERPLANETARY MEDIUM AND OF THE STRUCTURE OF RADIO SOURCES USING HIGHER

MOMENTS OF INTERPLANETARY SCINTILLATIONS. Bourgois, G.; Cheynet, C. (Observatoire de Meudon, France). Astron. Astrophys.; 21: No. 1, 25-31(Oct 1972).

A new method for studying interplanetary scintillations of radio sources is presented based upon the observation of moments of order 3 and 4 of the fluctuations of the received signal. From observations at 21 cm with the Nançay radiotelescope, it is shown that sufficiently far from the Sun the observed moments can be fitted to a Rice probability density function for the received electric field. It is shown that the skewness coefficient $\gamma_1 = M_3/M_2^{3/2}$ (M_2 and M_3 being the central moments of order 2 and 3) allows to determine the r.m.s. values of the phase shift introduced by the interplanetary plasma. On the other hand, the variations of γ_1 with the scintillation index determine the flux density ratio for assumed core-halo models of 3C 273 and 3C 279 in good agreement with the results of interferometer measurements. It was observed that the variations of γ_1 with the solar distance appear less sensitive to source structure than the variations of the scintillation index. This property, and the fact that γ_1 can be determined without any calibration, give much interest to the use of γ_1 to study the interplanetary medium. (auth)

59475 THEORETICAL STUDY OF THE HIGHER MOMENTS OF THE INTERPLANETARY SCINTILLATIONS. Bourgois, G. (Observatoire de Meudon, France). Astron. Astrophys.; 21: No. 1, 3308(Oct 1972).

Information on the interplanetary medium can be derived from the study of the skewness coefficient of the probability density function of the received intensity: γ_1. Generalizing the work of Mercier (1962), an expression is derived for γ_1 which is valid for all conditions of observation of interplanetary scintillations at sufficiently large distances from the Sun. (auth)

59476 OBSERVATIONS AT 750, 1400, AND 2700 MHz OF RADIO SOURCES IN THE VERMILION RIVER OBSERVATORY SURVEY. Webber, J. C.; Willis, A. G. (Univ. of Illinois, Urbana). Astron. J.; 77: No. 8, 625-36(Oct 1972).

For a sample of radio sources selected at 610.5 MHz, higher frequency measurements are given. 494 sources are listed, of which 410 have been observed at 2700 MHz and have positions accurate to ±20″. A spectral index and other catalog numbers are also listed. (auth)

59477 MEASUREMENTS OF THE FLUX DENSITY AND SPECTRA OF DISCRETE RADIO SOURCES AT CENTIMETER WAVELENGTHS. III. OBSERVATIONS OF WEAK SOURCES AT 2.7 AND 5 GHz. Pauliny-Toth, I. I. K. (Max Planck Institut fuer Radioastronomie, Bonn); Kellermann, K. I. Astron. J.; 77: No. 7, 56-08(Sep 1972).

Flux-density measurements at 2.7 and 5 GHz of 283 weak radio sources selected from the 178-MHz Ryle—Neville survey and the 408-MHz Bologna surveys, respectively, are given. The spectral-index distributions are compared with those for the stronger sources, and no relation is found up to source densities of 10^4 source sr^{-1}. (auth)

59478 NEW TECHNIQUES IN SPACE ASTRONOMY. Conference Held in Munich, Germany, August 10–14, 1970. Labuhn, F.; Luest, R. (eds.). International Astronomical Union Symposium No. 41. New York; Springer-Verlag New York Inc. (1971). 431p. (CONF-700859).

Papers on gamma and x-ray astronomy are included along with survey papers on the present state of stellar, interstellar, and solar observations in the uv-region of the spectrum. A survey on new radio astronomical observations from spacecraft is given. (W.D.M.)

59479 OBSERVATION OF A CORRELATED X-RAY–RADIO TRANSITION IN CYGNUS X-1. Tananbaum, H. (American Science and Engineering, Cambridge, Mass.); Gursky, H.; Kellogg, E.; Giacconi, R.; Jones, C. Astrophys. J.; 177: No. 1, L5-10 (1 Oct 1972).

Analysis of 16 months of Uhuru data on Cyg X-1 has shown a remarkable transition in the source which occurred during 1971 March and April. The average x-ray intensity in the 2 to 6 keV energy range decreased by about a factor of 4, the average x-ray intensity in the 10 to 20 keV band increased by a factor of 2, and a weak radio source suddenly appeared. This simultaneous x-ray and radio behavior provides strong evidence for the identification of the radio source with Cyg X-1. Uhuru also monitored Cyg X-1 for 35 consecutive days during 1971 December and 1972 January. The data were analyzed for an effect due to a binary system. Although large-scale fluctuations were present, no periodicity was found. (auth)

59480 ASYMMETRY OF SOFT X-RAY EMISSION NEAR M87. Catura, R. C.; Fisher, P. C.; Johnson, H. M.; Meyerott, A. J. (Lockheed Palo Alto Research Lab., Calif.). Astrophys. J.; 177: No. 1, L1-4(1 Oct 1972).

The angular distribution of x-ray emission near M87 has been measured at energies from 0.5 to 4 keV by a rocket-borne x-ray optical system. The observed distribution has an angular extent of 0.4 ± 0.1° and contains a compact component, coincident with M87, which is small compared with the instrument's angular resolution of 0.1°. The extended source is not centered on M87 but displaced by 0.2 ± 0.05° in the approximate direction of the bright jet associated with this galaxy. (auth)

59481 TRANSFER EQUATIONS FOR HIGH-ENERGY ELECTRONS AND PHOTONS IN MAGNETIC FIELDS. Ochelkov, Yu. P.; Rozental, I. L.; Shukalov, I. B. (Space Research Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 244-9(1972).

Translated from Astron. Zh.; 49: No. 2, 298-305(1972).

The transit of a beam of relativistic high-density electrons through strong magnetic fields is considered. This is characterized by the collective interaction of electrons and photons. Kinetic equations which describe the transit of such beams are presented along with certain particular solutions. Such a statement of the problem is essential in analyzing models of emitting regions of compact sources having a high luminosity. It is noted that the spectra of the electrons and photons may have a nonpower-law form even when the sources have the generally accepted power-law spectrum. The influence of collective interactions on the energy spectra is estimated. The overall approach is illustrated by estimating the parameters of the emitting region of the pulsar NP 0532. (auth)

59482 PRECISE POSITIONS OF RADIO SOURCES MEASURED AT 2695 MHz. Adgie, R. L.; Crowther, J. H.; Gent, H. (Royal Radar Establishment, Malvern, Eng.). Mon. Notic. Roy. Astron. Soc.; 159: No. 3, 233-51(1972).

The positions of 159 radio sources were measured at 2695 MHz with the interferometer at the Royal Radar Establishment, Malvern. The positions were calibrated with the positions of the optical counterparts of 36 identified radio sources. The standard error of measurement is believed to be 0.4 arc sec in both coordinates. (auth)

59483 HD 152667 AND SCO X-2. Walker, E. N. (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Notic. Roy. Astron. Soc.; 159: No. 3, 253-9(1972).

The spectroscopic binary P Cygni star HD 152667 lies close in the sky to the x-ray source Sco X-2. The existing photometry of this star was analyzed, and it was found that two solutions are possible. One is a conventional one and predicts that the unseen secondary is a B_3 V star. The alternative solution suggests that all photometric variations are due only to one, gravity darkened star filling its Roche lobe and accompanied by what could be a dense, massive companion. HD 152667 has many similarities to HDE 226868 which has been identified with the x-ray source Cyg X-1. (auth)

59484 SHORT-TERM PULSAR INTENSITY VARIATION IN THE FREQUENCY RANGE 70 TO 115 MHZ. I. CORRELATION MEASUREMENTS. Brezgunov, V. N.; Zlobin, V. N.; Udal'tsov, V. A. (Lebedev Physics Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 230-4(1972).

Translated from Astron. Zh.; 49: No. 2, 279-85(1972).

A correlation analysis of short-term intensity variations in pulsars CP 0808, 0834, 0950, and 1133 is presented. It was found that in all pulsars periodic variations at one or several low frequencies, which varied greatly from day to day, were observed. Further, a high degree of cross-correlation of intensity variations in the range 70 to 115 MHz, a dependence of the degree of correlation on frequency separation, and decorrelation at some frequencies on isolated days were found. (auth)

59485 INVESTIGATION OF THE FAINT NEBULA IDENTIFIED WITH RADIO SOURCE HB-21. Lozinskaya, T. A. Shernberg State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 219-23(1972).

Translated from Astron. Zh.; 49: No. 2, 265-70(1972).

Interferometric observations were made of optical hydrogen-alpha emission in the area of radio source HB-21, which has been identified with the remnants of a supernova outburst. A high-contrast Fabry—Perot etalon with a contact electronic image-converter tube was used. Statistical analysis of observational results made it possible to distinguish the emission of the extremely faint nebula from the background radiation. An expansion of the nebula at a rate of 22 ± 8 km/sec was revealed. (auth)

59486 OBSERVATIONS OF THE $^2PI_{3/2}$, $J = 5/2$ STATE OF INTERSTELLAR OH. Zuckerman, B. (Univ. of Maryland, College Park); Yen, J. L.; Gottlieb, C. A.; Palmer, Patrick. Astrophys. J.; 177: No. 1, 59-78(1 Oct 1972).

With the 140-foot (4267-cm) telescope of the National Radio Astronomy Observatory, OH Λ-doublet radiation at 5-cm wavelength was observed in the direction of six sources: W3, W75N, NML Cyg, W49, Sgr B2, and NGC 6334N. The F = 3 → 3 transition was detected in all six sources and the F = 2 → 2 transition in W3 and NGC 6334N. The lines were generally narrow and circularly polarized similar to ground-state OH maser radiation at 18-cm wavelength. The 5-cm intensities were typically a few percent of the 18-cm intensities but with wide variations from source to source. The line in NML Cyg was the first excited-state OH line detected from an infrared star; its radial velocity agreed neither with the ground-state OH nor with the H_2O velocities. An extremely peculiar time variation was observed in NGC 6334N. (auth)

59487 FLUX-DENSITY SCALE FOR MICROWAVE FREQUENCIES. Dent, William A. (Univ. of Massachusetts, Amherst). Astrophys. J.; 177: No. 1, 93-9(1 Oct 1972).

Accurate flux-density measurements of the thermal radio source DR 21 were made at centimeter wavelengths relative to the KPW absolute flux-density scale based on Cas A and at millimeter wavelengths relative to absolute brightness-temperature measurements of Jupiter and Saturn. The absolute spectrum of DR 21 thus defined has the form $S_\nu = 26.8 - 5.6 \log \nu$ (GHz) for $\nu \geq 7$ GHz, and ties together two formerly independent flux-density scales. With an accuracy of about 3%, this spectrum of DR 21 defines a flux-density scale that can be used to calibrate antennas having beamwidths between 1 and 6 minutes of arc at microwave frequencies above 7 GHz where other methods of absolute calibration are much less accurate. (auth)

59488 VERY LONG BASELINE INTERFEROMETER OBSERVATIONS OF TAURUS A AND OTHER SOURCES AT 121.6 MHz. Erickson, W. C. (Univ. of Maryland, College Park); Kuiper, T. B. H.; Clark, T. A.; Knowles, S. H.; Broderick, J. J. Astrophys. J.; 177: No. 1, 101-14(1 Oct 1972).

VLBI observations with an antenna spacing of 92,000 λ (2.2″ lobe separation) were made on a number of small-angular-diameter sources at a frequency of 121.6 MHz. Through positional and spectral coincidence, these observations confirm the physical association of the compact source in Tau A with the pulsar NP 0532; in the east—west direction, the two objects agree in position to an accuracy of ±0.1. The fluxes of the small-angular-diameter components of 3C 48, 3C 84, 3C 144, 3C 147, 3C 273, 3C 274, 3C 298, 3C 405, 3C 459, and 3C 461 were estimated. (auth)

59489 ABSORPTION BY THE INTERSTELLAR MEDIUM OF 80 MHz RADIO EMISSION FROM GALACTIC SUPERNOVA REMNANTS. Dulk, G. A. (Univ. of Colorado, Boulder); Slee, O. B. Aust. J. Phys.; 25: No. 4, 429-41(Aug 1972).

High resolution 80 MHz observations of 20 galactic supernova remnants were made with the Culgoora radioheliograph. More than half of the sources have an unexpectedly low flux density at 80 MHz, probably as a result of free—free absorption taking place in the inner arms of the Galaxy. The observations imply an rms electron density of about $0.1-0.5$ cm^{-3} along the line of sight. This large value for the electron density seems to require a greater ionizing flux than that which occurs in the solar vicinity. (Australia)

59490 DOPPLER EFFECTS AND HYPERVELOCITIES OF 3C 279 SOURCES. Gregory, C. (Univ. of Hawaii, Honolulu). Nature (London) Phys. Sci.; 239: No. 91, 56-7(25 Sep 1972).

It is stated that recent interpretations of radio interferometric experiments on 3C 279 as due to a symmetric double source which apparently separates at a speed of ten times that of light raise the questions of whether the Doppler effect exists at superluminal velocities and what mechanism gives rise to such velocities. It is possible to discuss some aspects of the first question within the framework of ordinary physical principles largely without depending too much on a revision of the usual views of space and time, but with regard to the second question a proposal is made for modifying ideas on dimensionality in order to account for the hypervelocities. It is concluded that it appears possible to extend the formalism of relativity theory to describe hypervelocities, and if these exist the Doppler effect must be considered. Consequences of the transformation of ordinary optical spectra to the x-ray or γ-ray regions should also be noted, together with the possibility of using related information to measure the superluminal velocities spectroscopically. (UK)

59491 POINT SOURCES OF GAMMA-RAYS OF ENERGY >10^{12} eV IN CASSIOPEIA AND CYGNUS REGIONS. Stephanyan, A. A.; Vladimirskii, B. M.; Fomin, V. P. (Crimean Astrophysical Observatory, USSR). Nature (London) Phys. Sci.; 239: No. 90, 40-1(18 Sep 1972).

It is stated that a search for point sources of high-energy γ rays (>10^{12} eV) using extensive air shower Cherenkov flashes has been continuing at the Crimean Astrophysical Observatory since 1969. The installation consists of four 1.5 m parabolic mirrors with fast photomultipliers in the focal planes, the mirrors being combined to form a system of two completely independent pairs of detectors. A drift scanning approximately along the galactic plane was made in 1971 to observe the γ-ray flux from the galactic disk. Some excess in counting rate was observed for scans made in September and October. The γ-ray flux was about 10^{-10} quanta/cm^2/sec for a threshold energy of 2×20^{12} eV. No pulsars or x-ray sources were detected in the direction of the hypothetical high-energy source, but a weak radio source (4C62.02) was detected. Observations were also continued of γ-ray flux from the Cygnus region, but no significant excess in counting rate was found in this direction, and it is assumed that the high-energy source in Cygnus may be a variable. It is suggested that all high-energy γ sources are variable, but further confirmation is necessary. (UK)

59492 RATIO OF TWO FLUX DENSITY SCALES AT 408 MHz. Conway, R. G.; Munro, R. E. B. (Nuffield Radio Astronomy Labs., Jodrell Bank, Eng.). Mon. Notic. Roy. Astron. Soc.; 159: No. 3, 21P-4P(1972).

A comparison between two sets of measurements of the flux density of radio sources at 408 MHz confirms that the CKL scale of flux density (Conway, Kellermann and Long, Mon. Not. R. Astr. Soc.; 125: 261(1963)) at this frequency differs significantly from the absolute scale due to Wyllie (Mon. Not. R. Astr. Soc.; 142: 229(1969)). To be consistent with the Wyllie scale, CKL flux densities should be increased by 1.087 ± 0.028. (auth)

59493 PRESSURE BROADENING OF RADIO RECOMBINATION LINES. Peach, G.; Seaton, M. J. (University Coll., London). Comments At. Mol. Phys.; 3: No. 4, 107-12(Jul 1972).

A discussion is presented on the physical processes that determine the profiles of radio lines, and comments are offered on the interpretation of observations. Consideration is given to Doppler, Stark, and impact broadening. (UK)

Solar Phenomena

59494 QUIET SUN BRIGHTNESS DISTRIBUTION AT MILLIMETER WAVELENGTHS AND CHROMOSPHERIC INHOMOGENEITIES. Lantos, P.; Kundu, M. R. (Univ. of Maryland, College Park). Astron. Astrophys.; 21: No. 1, 119-24(Oct 1972).

The quiet Sun brightness distributions at 9 and 3.5 mm wavelengths are presented. The distribution at 9 mm shows definite limb brightening whereas the distribution at 3.5 mm shows slight limb darkening. The distribution at 1.2 mm wavelength is known to exhibit definite limb darkening (Kundu, 1971). These distributions are interpreted in terms of a two-component chromospheric model. (auth)

59495 SOLAR CHROMOSPHERE AND ITS TRANSITION TO THE CORONA. Frisch, H. (Nice Observatory). Space Sci. Rev.; 13: No. 3, 455-83(Jul 1972).

Present knowledge on the average physical properties of the chromosphere and of the transition region between chromosphere and corona is reviewed. It is recalled that shock-wave dissipation is responsible for the high temperatures observed in the chromosphere and corona and that, due to the nonlinear character of the dissipation mechanism, no satisfactory explanation of the structure of the outer solar layers has yet been given. In this paper, the main emphasis is on the observations and their interpretation. Evidence for the nonspherically symmetric structure of the atmosphere is given; the validity of interpreting the observations with the help of a fictitious spherically symmetric atmosphere is discussed. The chromosphere and the transition region are studied separately: for each region, the energy balance is considered and recent homogeneous models derived from ultraviolet, infrared, and radio observations are discussed. It is stressed that although in the chromosphere, a study of the radiative losses may lead to the determination, as function of height, of the amount of mechanical energy dissipated as function of height, a more detailed analysis of the velocity field is necessary to find the periods and the wavelengths of the waves responsible for the heating. The methods used for wave detection and some results are presented. Observational and theoretical evidence is given for the nonvalidity of the assumption of hydrostatic equilibrium that is commonly used in modeling the transition region. It is concluded that a better understanding of the heating mechanism will come through a higher spatial resolution (less than 0.2″) and more accurate absolute measurements, rather than from sophisticated hydrodynamic calculations. (102 references) (auth)

59496 AUGUST SOLAR ACTIVITY AND ITS GEOPHYSICAL EFFECTS. McIntosh, Patrick S. (Environmental Research Labs., Boulder, Colo.). Sky Telesc.; 44: No. 4, 214-17(Oct 1972).

Solar activity between July 29 and Aug 11, 1972 associated with the active region 11976 is summarized along with the related geophysical effects. (W.D.M.)

59497 GREAT SOLAR FLARES OF AUGUST 1972. Rust, David M. Sky Telesc.; 44: No. 4, 226-30(Oct 1972).

Solar flares of Aug 7 and 11, 1972 were observed at the Sacramento Peak Observatory in New Mexico. These observations are briefly summarized. (W.D.M.)

59498 PROBLEM OF THE NEUTRINO BRIGHTNESS OF THE SUN. Polievktov-Nikoladze, N. M. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR; 67: No. 2, 321-3(Aug 1972). (In Russian).

It is shown that if anomalies of the neutrino brightness of the Sun are caused by gravitational effects, then they speak not only against the Brans and Dicke scalar-tensor theory, but also against gravitation being in the class of the other elementary interactions. In such a case gravitation equations should be with higher than the second-order derivatives. (auth)

59499 FURTHER IRON-LINE OBSERVATIONS DURING SOLAR FLARES. Doschek, G. A. (Naval Research Lab., Washington, D. C.); Meekins, J. F.; Cowan, Robert D. Astrophys. J.; 177: No. 1, 261-9(1 Oct 1972).

Transitions in Fe XXIV of the type $1s^2 2l\,{}^2L-1s^2 4l'\,{}^2L'$, and the Fe XXIII transition, $1s^2 2s^2\,{}^1S_0-1s^2 2s4p\,{}^1P_1$, are identified in soft x-ray spectra of solar flares. The relative line strengths of Fe XXIV are compared with theory, and the temporal behavior of the Fe XXIV lines and the Fe XXIII line is discussed, particularly with reference to the continuum emission near 8 Å. (auth)

59500 ALFVENIC MOTIONS IN THE SOLAR ATMOSPHERE. Hollweg, Joseph V. (California Inst. of Tech., Pasadena). Astrophys. J.; 177: No. 1, 255-9(1 Oct 1972).

The amplitude of bulk velocities associated with upward-propagating Alfvén waves in the lower solar atmosphere is discussed. It is shown that for a given wave energy flux, the bulk velocities can be appreciably lower in cases when the wavelength is much larger than the scale height, than in situations where the wavelength is smaller than the scale height. In the chromosphere and lower corona, the former case pertains to waves with dominant timescales of 1−2 hours, as is found for Alfvén waves observed in the solar wind at 1 a.u., or to supergranulation-driven waves with dominant timescales of the order of the supergranular lifetime, ~20 hours. This has the important consequence that Alfvén waves with energy fluxes of several thousand to a few tens of thousand ergs $cm^{-2}\ s^{-1}$ at the Sun (such fluxes have been predicted for supergranulation-driven Alfvén waves, and can play a significant role in the dynamics of the solar wind) can have bulk velocity amplitudes $\lesssim 3\ km\ s^{-1}$ at heights less than 50,000 km above the solar limb, if the general solar field strength is at least 2 gauss. Such velocities are consistent with observational limits to bulk velocities in the lower solar atmosphere. (auth)

59501 PREFERENTIAL ACCELERATION OF HEAVY NUCLEI IN SOLAR FLARES. Cartwright, Brian G.; Mogro-Campero, Antonio (Univ. of Chicago). Astrophys. J.; 177: No. 1, L43-7 (1 Oct 1972).

Several recently reported measurements of the relative abundances of heavy nuclei ($Z \gtrsim 8$) accelerated in solar flares have shown a significant enhancement of these nuclei compared with solar photospheric and coronal abundances. A mechanism is proposed for the preferential acceleration of heavy nuclei. The model consists of two acceleration stages: fully stripped ions are first accelerated to suprathermal energies, and subsequently a fraction of these ions are Fermi-accelerated to higher energies. Transport to the Fermi-acceleration region involves electron pickup; injection into Fermi acceleration is rigidity dependent. A consideration of these processes shows that enhancement of the abundance of heavy nuclei can occur. The degree of this enhancement is expected to vary from flare to flare. Thus, this model can also account for measurements which have not shown such enhancements. (auth)

59502 NATURAL OSCILLATIONS OF TYPE-I COMET TAILS. Ershkovich, A. I.; Chernikov, A. A. (Cosmic Research Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 374-6 (1972).

Translated from Astron. Zh.; 49: No. 2, 458-61(1972).

It is shown that the almost-periodic variations in the orientation of Type-I comet tails with a period of a few hours, first described by Bessel in 1836, and also the observed rotational motions about the axis of the tail are apparently an effect of natural oscillations induced by fluctuations in the parameters of the solar wind. (auth)

59503 ELECTROMAGNETIC FLUCTUATIONS IN A MAGNETIC RADIATION. Yukhimuk, A. K. (Inst. of Geophysics, Kiev). Geomagn. Aeron. (USSR) (Engl. Transl.); 12: No. 1, 96-9(1972).

Translated from Geomagn. Aeron.; 12: No. 1, 116-18(1972).

Strong electromagnetic radiation fluxes frequently occur in a plasma under astrophysical conditions, such as during radio noise bursts of types II, III, and IV on the Sun. The high density of electromagnetic radiation in a plasma must give rise to fluctuations and also to a sharp increase in fluctuating electric fields. An analysis is made of electron drift in the field of a strong electromagnetic wave and the conditions under which lf fluctuations are excited in a magnetized plasma. Spectral energy distribution of the fluctuating fields of Alfvén and spiral waves on the basis of the kinetic theory is also analyzed. (auth)

59504 SIMILARITY ANALYSIS OF THE CIRCULATION ON THE SUN. Golitsyn, G. S. (Inst. of Atmospheric Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 294-9(1972).

Translated from Astron. Zh.; 49: No. 2, 360-6(1972).

The similarity theory developed by the author for the general circulation of planetary atmospheres is modified to yield estimates for the differentially rotating Sun. The basic theoretical expression for the total circulation kinetic energy E now incorporates the dimensionless rotation number λ (the rotational Mach number) even for small λ, since the hydrothermodynamic nonequilibrium in the solar interior responsible for the circulation (the differential rotation) is in turn presumably caused by the general rotation of the Sun. The functional factor $f(\lambda)$ appearing in E for small λ is approximated by the first term in its λ-expansion, which is proportional to $\lambda^2 \sim \omega^2$. The estimate $E \approx 10^{36}$ ergs is obtained; the circulation penetrates to a depth of ≈20% of the solar radius, in agreement with estimates for the depth of the convection zone. The circulation "lifetime," estimated as ≈2 months, agrees with Ward's estimate from the observations. The efficiency of the solar atmosphere in converting the power supplied to it into energy is $\approx 5 \cdot 10^{-5}$. The temperature difference between the equatorial and polar regions in the solar interior is typically of the order of several tens or a hundred degrees. (auth)

59505 RELATIVE POLARIZATION OF TYPE III SOLAR RADIO BURSTS AT 23.5 AND 30 MHz. Krueger, A.;Fomichev, V. V.; Chertok, I. M. (Heinrich Hertz Central Inst. of Solar-Terrestrial Physics, USSR). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 290-3(1972).

Translated from Astron. Zh.; 49: No. 2, 355-9(1972).

The mean percentage polarization of Type III bursts at 23.5 and 30 MHz is compared, using observations made at the Heinrich Hertz Institute during 1965−1968. The polarization is several percent higher, on the average, at 23.5 than at 30 MHz. The excess of m_{23} over m_{30} is attributed to certain properties of the corresponding active regions at the photospheric level; for example, it is related to the area of the largest (leading) spot in a group and to the magnetic class of the group. This circumstance imposes definite constraints on the ratios of the electron-density gradients and magnetic-field strengths in the region where the radio emission at these frequencies is generated. (auth)

59506 PROPAGATION THROUGH THE SOLAR CORONA OF THE SHOCK WAVES RESPONSIBLE FOR TYPE II RADIO BURSTS. Fomichev, V. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 284-9(1972).

Translated from Astron. Zh.; 49: No. 2, 348-54(1972).

A discussion is given of the manner in which the parameters of shock waves vary during propagation through the solar corona, according to observations of nine Type II radio bursts. It is shown that the radio emission in the bursts can terminate either because of the declining intensity of the shock waves, or when a wave "breaks." The velocity of the shocks also varies in different ways: Along with cases of acceleration, there are cases where shocks are retarded as they travel through the corona. The diversity in the behavior of shock waves in the corona appears to be reflected in the diversified behavior of shocks in interplanetary space. (auth)

59507 HEATING OF PLASMA BY HIGH-ENERGY ELECTRONS, AND NONTHERMAL X-RAY EMISSION IN SOLAR FLARES. Syrovat'skii, S. I.; Shmeleva, O. P. (Lebedev Inst. of Physics, USSR). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 273-83(1972).

Translated from Astron. Zh.; 49: No. 2, 334-47(1972).

The power transferred to a plasma by a stream of fast particles through collisional losses is calculated as a function of depth in the layer, for a power-law particle energy distribution. The results are applied to solar flares, assuming that electrons carry most of the energy of the accelerated particles. The slope of the energetic-electron spectrum, the total energy, and the number of particles can be determined from the nonthermal x-ray spectrum of a flare with no additional assumptions regarding the plasma density or the flare geometry. If ionization losses are taken into account, the equilibrium spectrum of the radiating electrons is found to be much harder than the spectrum of the electrons injected into the plasma: There is a difference of 2 in the spectral indices. The total energy imparted to the plasma by energetic-electron streams is estimated for several actual flares. It is shown that this energy comprises a substantial, and perhaps a predominant, portion of the total energy of a flare. (auth)

59508 FISSION XENON FROM EXTINCT ^{244}Pu IN 14301. Drozd, R.; Hohenberg, C. M.; Ragan, D. (Washington Univ., St. Louis). Earth Planet. Sci. Lett.; 15: No. 3, 338-46(Jul 1972).

Xenon extracted in step-wise heating of lunar breccia 14301 contains a fission-like component in excess of that attributable to uranium decay during the age of the solar system. There seems to be no adequate source for this component other than ^{244}Pu. Verification that this component is in fact due to the spontaneous fission of extinct ^{244}Pu comes from the derived spectrum which is similar to that observed from artificially produced ^{244}Pu. It thus appears that ^{244}Pu was extant at the time lunar crustal material cooled sufficiently to arrest the thermal diffusion of xenon. Subsequent history has apparently maintained the isotopic integrity of plutonium fission xenon. Of major importance are details of the storage itself. Either the fission component is the result of in situ fission of ^{244}Pu and subsequent storage in 14301 material, or the fission xenon was stored in an intermediate reservoir before incorporation into 14301. In the former case accurate dating of this material is possible which would place formation of lunar crustal material early in primitive solar system history (nearly simultaneous with meteorite parent-body formation). In the latter case accurate dating is not possible, but the implied re-implantation from a source rich in fission xenon still demands that the Moon was once primitive enough to contain large amounts of now extinct ^{244}Pu and at the same time cool enough to prevent xenon isotopic mixing. (auth)

59509 SPECTRUM OF FeH: LABORATORY AND SOLAR IDENTIFICATION. Carroll, P. K.; McCormack, P. (Univ. Coll., Dublin). Astrophys. J.; 177: No. 1, L33-6(1 Oct 1972).

A new complex molecular spectrum was observed under high resolution in the blue—green region. The molecule responsible was identified as FeH, for which no spectrum has, up to the present, been reported. A King furnace was used in the experiments, and observations were made in both emission and absorption. Comparison of the laboratory wavelengths with those in the revised Rowland table shows many coincidences with weak unidentified solar lines, especially lines which either are enhanced in the sunspot spectrum or are observed only in the spot. (auth)

59510 ABUNDANCES OF SOLAR ACCELERATED NUCLEI FROM CARBON TO IRON. Mogro-Campero, Antonio; Simpson, J. A. (Univ. of Chicago). Astrophys. J.; 177: No. 1, L37-41 (1 Oct 1972).

From revised observation periods and new data it is found that the overabundance of solar-flare nuclei with respect to solar photospheric or coronal abundances increases with increasing atomic number. Since there are large differences reported by investigators regarding the magnitude of the solar-flare high-Z particle enhancements, it was investigated and verified that there exists a variability of enhancements from flare to flare which is large enough to account for the differences. It is found that the solar acceleration mechanism may be a two-stage process, and it is pointed out that the galactic cosmic-ray source composition displays a similar overabundance as a function of atomic number. (auth)

59511 WHAT MAKES ACTIVE REGIONS GROW? Weart, Spencer (Carnegie Institution of Washington, D. C.). Astrophys. J.; 177: No. 1, 271-6(1 Oct 1972).

The growth, or failure to grow, of well over 100 active regions was studied. Most growth is connected with the emergence of a large batch of flux in the shape of a new Arch Filament System (AFS). During the recent sunspot maximum, new AFSs appeared at a rate of nearly one per day over the entire Sun. They are seen popping up at random points, not only in quiet parts of the Sun, but also within old active regions; and more often than chance would predict, they come up right in the middle, on the site of preexisting AFSs. These AFS appearances and rejuvenations account for most of the growth of active regions. Evidence is presented for the hypotheses that (1) a twist in the flux tubes of new AFSs is a key factor in determining which new AFSs will grow, and (2) this twist is related to the well-known asymmetry of sunspot groups. (auth)

59512 INTERPLANETARY GAS. XVII. AN ASTROMETRIC DETERMINATION OF SOLAR-WIND VELOCITIES FROM ORIENTATIONS OF IONIC COMET TAILS. Brandt, John C. (Goddard Space Flight Center, Greenbelt, Md.); Roosen, Robert G.; Harrington, Robert S. Astrophys. J.; 177: No. 1, 277-84(1 Oct 1972).

A statistical analysis of ionic comet-tail position angles on the sky using no weights and no assumptions of coplanarity yields a model of the solar wind with mean properties of a radial bulk velocity $w_r = 415$ km s^{-1}, azimuthal bulk velocity $w_\phi = 6$ km s^{-1}, polar bulk velocity $w_\theta = 0$ km s^{-1}, and an isotropic, peculiar velocity of about 40 km s^{-1}. These results and particularly the value for w_θ are in accord with recent spacecraft results. Thus, the solar wind slows the solar rotation with an e-folding time comparable to the age of the Sun. (auth)

59513 COLLISIONLESS PLASMA FLOW OVER A CONDUCTING SPHERE. Stone, N. H. (Marshall Space Flight Center, Huntsville, Ala); Oran, W. A.; Samir, Uri. Planet. Space Sci.; 20: No. 10, 1787-90(Oct 1972).

Studies were made of the disturbed zone around satellites caused by the interaction between the spacecraft and its environmental space plasma. In situ observations are fragmentary but the data available were used to examine various theories. Laboratory simulation is considered as a complementary study. Experiments were carried out in a plasma wind tunnel, mapping the entire zone of disturbance behind the body. Preliminary results are presented for transverse ion profiles at various positions along the wake axis. An interpretation is proposed, in terms of two converging ion streams in a highly rarefied collisionless plasma. (UK)

59514 BACKSCATTER OF SOLAR RESONANCE RADIATION. 2. Johnson, H. E. (Univ. of California, San Diego La Jolla). Planet. Space Sci.; 20: No. 10, 1784-5(Oct 1972).

Calculated curves are presented for the intensity of scattered solar Lyman α (λ1216 HI) which would be observed from a deep space probe at various distances from the Sun as a function of the angle away from the pole, where the pole is the direction of the projection onto the ecliptic plane of the direction of the solar apex. (UK)

59515 DETECTION OF INTERPLANETARY ELECTRONS FROM 18 keV TO 1.8 MeV DURING SOLAR QUIET TIMES. Lin, R. P. (Univ. of California, Berkeley); Anderson, K. A.; Cline, T. L. Phys. Rev. Lett.; 29: No. 15, 1035-8(9 Oct 1972).

A quiet-time component of interplanetary electrons was observed having energies above solar-wind energies and below those characterized as cosmic radiation. Its energy spectrum generally falls with energy from 18 keV to 1.8 MeV, but shows a feature at 100 to 300 keV. The observed temporal variations of the intensity suggest that the 18 to 100-keV portion is solar and the 0.3 to 1.8-MeV portion is galactic in origin. Solar and terrestrial neutron-decay electrons appear inadequate to explain the 100 to 300-keV feature. (auth)

59516 ORIGIN OF 200-keV INTERPLANETARY ELECTRONS. Ramaty, R.; Cline, T. L.; Fisk, L. A. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev. Lett.; 29: No. 15, 1039-42(9 Oct 1972).

A spectral feature at ~200 keV in the recently observed intensity of interplanetary electrons is examined as to its possible solar, interplanetary, or galactic origin. (auth)

Galaxies

Refer also to abstracts 59404 and 59561.

59517 SURVEY OF LINEAR POLARIZATION AT 1415 MHz. IV. DISCUSSION OF THE RESULTS FOR THE GALACTIC SPURS. Spoelstra, T. A. Th. (Leiden Observatory). Astron. Astrophys.; 21: No. 1, 61-84(Oct 1972).

The results of a survey of linear polarization at 1415 MHz in the galactic spurs are discussed. Maxima in the polarization intensity occur near or on the continuum ridges of the galactic spurs. In the Cetus Arc and Loop III ($b \sim 35°$) the maxima in the polarization intensity are shifted with respect to the continuum maxima. No shift occurs in the North Polar Spur and Loop III ($b > +40°$). The polarization direction is parallel to the North Polar Spur at $b > +50°$ and to the Cetus Arc ($b < -20°$), but perpendicular to the North Polar Spur at $b < +40°$, and complex in Loop III. The precentage polarization in the North Polar Spur is close to the maximum possible. In the North Polar Spur at $b > +50°$ the optical polarization direction tends to be perpendicular to the intrinsic radio polarization direction. On the assumption that the optical and radio polarization are associated a distance of between 50 and 100 pc is found for the North Polar Spur at $b > +50°$. The component of the magnetic field perpendicular to the line of sight is along the North Polar Spur at b > +50° and perpendicular to it at b < +40°; it is parallel to the Cetus Arc at b < −20°, and complex in Loop III. An association of the polarization characteristics with H I distribution is not obvious. Van der Laan's model of a shell expanding into the interstellar medium gives a reasonable explanation of the observed continuum features and polarization characteristics. (auth)

59518 POSSIBLE EXISTENCE OF DIFFERENT INTERSTELLAR EXTINCTION LAWS IN THE SPIRAL ARMS AND IN THE FIELD REGIONS. Creze, M. (Observatoire de Paris, France). Astron. Astrophys.; 21: No. 1, 85-9(Oct 1972).

The ratio R of total to selective extinction is derived from a comparison of spectroscopic and photometric data with the kinematical parallaxes computed from radial velocities, through a model of galactic differential rotation. H II regions, Population I Cepheids, and open clusters are used for this purpose. R is shown to depend on both galactic longitude and color excess. The galactic longitude variation appears to be strongly correlated with the local spiral structure and the dependence on color excess confirms the correlation observed by Fernie and Marlborough (1963). Both these phenomena can be explained if the interstellar extinction law is different in and outside the galactic spiral arms. This difference may result either from a different chemical composition or from a different size distribution of the interstellar grains. R should vary from about 1.5 to about 4.0 according as the part of the line of sight lying inside the spiral arms is near zero or very large (about 2 kpc). (auth)

59519 SPECTROPHOTOMETRIC STUDIES OF GASEOUS NEBULAE. Hua, C. T. (Observatoire de Marseille). Astron. Astrophys.; 21: No. 1, 105-9(Oct 1972). (In French).

The energy distribution in the continuum of the Orion nebula has been determined spectrophotometrically with respect to several standards of the Barbier−Chalonge−Divan classification, by using the short-dispersion slit spectrograph (Baillet and Chalonge, 1952) at the Cassegrain focus of various reflectors (10-inch, 16-inch and 32-inch) at the Haute Provence Observatory. The color temperature of 12,000°K on both sides of the Balmer limit is in good agreement with Greenstein's measures (1946). However, the value of the Balmer jump, 0.39 in log I, is smaller than both Barbier's and Greenstein's determinations. On the assumptions of an optically thin nebula ($\tau_\lambda \lesssim 0.1$) for the range λλ 3000 to 5000, an attempt is made at calculating the contribution of scattered light in the central part of the nebula. (auth)

59520 COLLAPSE OF A MASSLESS, NONROTATING CLOUD AROUND A POINT NUCLEUS. Wright, Alan E.; Innanen, K. A. (York Univ., Downsview, Ont.). Astron. Astrophys.; 21: No. 1, 151-3(Oct 1972).

The limiting inhomogeneous contraction of a spherical cloud of gas may be represented by the collapse of a massless spheroid of gas around a massive point nucleus. For this case, it is shown analytically that in the absence of rotation the gas envelope attains an "infinity-sign" shape given in polar coordinates by $r \alpha \cos^{1/3} \theta$ at the instant of the central signularity for a small initial spheroidal eccentricity. Additional terms are developed for larger initial eccentricity. Some relevant possible interpretations of observations in the galactic system are briefly considered. (auth)

59521 H I VELOCITY−LONGITUDE DIAGRAM FOR THE SOUTHERN MILKY WAY. Knapp, G. R. (Univ. of Maryland, College Park). Astron. Astrophys.; 21: No. 1, 163-5(Oct 1972).

An observational velocity−longitude diagram derived from 21-cm hydrogen-line observations from longitude 190° to 12°, taken with the Parkes radio telescope, is presented. The diagram consists of continuous features followed in longitude with available latitude information taken into account. The extreme complexity of the structure seen on this diagram probably reflects complex structure of the Galaxy. (auth)

59522 IDENTIFICATION OF 4C SOURCES WITH GALAXIES. Hazard, C. (Inst. of Theoretical Astronomy, Cambridge, Eng.); Jauncey, D. L. Astron. J.; 77: No. 8, 621-4(Oct 1972).

Identification with galaxies for 59 radio sources from the 4C catalogue is suggested. (auth)

59523 LOW FREQUENCY RADIO OBSERVATIONS OF THE ANDROMEDA GALAXY. Durdin, John M.; Terzian, Yervant (Cornell Univ., Ithaca, N. Y.). Astron. J.; 77: No. 8, 637-41 (Oct 1972).

Radio observations of M31 and its halo are presented at 73.8, 111.5, and 196.5 MHz. These observations were performed with the NAIC 1000-ft radio telescope. Brightness-temperature contour maps are presented and the spectrum of M31 and its halo are discussed. It may be possible that the spectrum of the observed region flattens out at frequencies ≲200 MHz. (auth)

59524 ELECTROGRAPHIC PHOTOMETRY OF NGC 4881. Ables, Harold D.; Ables, Paula G. (Naval Observatory, Flagstaff, Ariz.). Astron. J.; 77: No. 8, 642-8(Oct 1972).

Luminosity profiles, integrated magnitudes, effective diameters, and other photometric parameters are derived for the Coma cluster galaxy, NGC 4881, from V and B electrographic plates taken with a Kron electronic camera attached to the 40-inch Ritchey−Chrétien telescope. The total apparent magnitudes are $V_T = 13.64$ and $B_T = 14.61$, which correspond to the absolute magnitudes, $M_V = -20.51$ and $M_B = -19.59$, if $m_0 - M = 34.0$ ($\Delta = 63$ Mpc), $A_V = 0.15$ mag, and $A_B = 0.20$ mag. The effective radii and surface brightnesses in V and B are $r_e(V) = 9.23$ arc sec = 2.82 kpc, $\mu_e(V) = 21.78$ mag sec^{-2}, and $r_e(B) = 9.86$ arc sec = 3.01 kpc, $\mu_e(B) = 22.87$ mag sec^{-2}. The luminosity profiles indicate the presence of a weak lens which suggests that NGC 4881 is probably a lenticular S0 galaxy rather than an E0 as previously classified. (auth)

59525 UPPER LIMIT ON THE OH ABUNDANCE IN THE INTERCLOUD MEDIUM. Knapp, G. R.; Kerr, F. J. (Univ. of Maryland, College Park). Astron. J.; 77: No. 8, 649-51(Oct 1972).

A search for weak OH emission at 1665 and 1667 MHz was carried out in three high-latitude directions containing no compact clouds of H I or dust. No OH emission was detected down to low limits, and the comparison of the upper limits with the known H I and dust-column densities reinforces the suggestion that OH tends to be concentrated in regions of high dust or gas density. (auth)

59526 VELOCITY STRUCTURES IN HYDROGEN PROFILES. Tuve, Merle A.; Lundsager, Soren (Carnegie Institution of Washington, D. C.). Astron. J.; 77: No. 8, 652-60(Oct 1972).

An atlas based on more than 5000 hydrogen Doppler profiles has been made ready for publication as a Carnegie Institution Monograph. Discussion of this material reaffirms a reluctant earlier conclusion that interpreting conspicuous Doppler peaks and trends as hydrogen concentrations in spiral arms is not justified or tenable, because it assumes an extremely regular rotation curve. Model studies show that perturbations of the velocity field by as little as 3% can give rise to large Doppler peaks and trends, traditionally interpreted as "arms," as noted earlier by Burton (1971). It is felt that Doppler-velocity structures usually referred to as the Scutum, Sagittarius, Perseus, and other Arms should not be interpreted as confirmed concentrations of neutral hydrogen in the Galaxy. (auth)

59527 SPIRAL STRUCTURE OF OUR GALAXY. Conference Held in Basel, Switzerland, August 29–September 4, 1969. Becker, W.; Contopoulos, G. (eds.). International Astronomical Union Symposium No. 38. New York; Springer-Verlag New York Inc. (1970). 488p. $24.40. (CONF-690846).

This symposium gives an account of recent observational and theoretical results concerning spiral structure, with the main emphasis on the spiral structure of the Milky Way. Spiral structure in other galaxies, where observations are much easier than in the Milky Way, is considered. Many new observational results about the spiral structure of the Milky Way are given. The theoretical developments contain many recent results of the gravitational theory of spiral structure. Various comparisons between theory and observations are given. (W.D.M.)

59528 EVOLUTION OF INTERSTELLAR CLOUDS. I. Meszaros, P. (Univ. of California, Berkeley). Astrophys. J.; 177: No. 1, 79-92(1 Oct 1972).

The consequences of the depletion of heavy elements on grains are examined in the two-phase model of the interstellar medium. It is found that, if depletion is important in the cloud phase, then clouds left to evolve in the absence of external dynamical perturbations must heat up gradually, and eventually destroy themselves on timescales of the order of 3×10^7 years. (auth)

59529 DIRECTION OF WINDING IN SPIRAL GALAXIES. Polyachenko, V. L.; Fridman, A. M. (Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 300-2(1972).

Translated from Astron. Zh.; 49: No. 2, 367-70(1972).

The controversial question of the direction of winding of spiral arms is discussed. Previous theoretical results conflict with the observations. A criterion is obtained for the formation of trailing spirals in a flat rotating disk with an arbitrary radial dependence for its angular rotational velocity and surface density. Observationally, the steady-state properties of the flat systems in the great majority of spiral galaxies appear to satisfy this criterion. A rigidly rotating disk and a disk with a large central mass are considered as examples. In the first case only trailing spirals can form. In the second case trailing spirals will form if the density of the flat subsystem falls off with radius more steeply than $r^{-3/2}$; otherwise a leading spiral can form with a narrow central region, but beyond, it will change over to a trailing spiral. (auth)

59530 GENERATION OF THE LARGE-SCALE GALACTIC MAGNETIC FIELD. II. Vainshtein, S. I.; Ruzmaikin, A. A. (Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 365-7(1972).

Translated from Astron. Zh.; 49: No. 2, 449-52(1972).

A steady-state galactic magnetic field is discussed in the case where the field is excited by the method described by Vainshtein and Ruzmaikin (1971). The azimuthal component of the field is found to be the basic component, in accordance with observations. (auth)

59531 GAS EJECTIONS IN NGC 4486 AND PROBLEMS OF THE ACTIVITY OF GALACTIC NUCLEI. Shklovskii, I. S. (Inst. of Space Research, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 193-200(1972).

Translated from Astron. Zh.; 49: No. 2, 233-42(1972).

The problem of the nature of the gaseous "counter-jet" and so-called "fan jet" in NGC 4486 is discussed. The former is formed by the ejection of matter in the direction of the rotation axis of a certain compact body: the nucleus. The subsequent motion of the clouds of ejected gas is controlled by a regular magnetic field which extends over many thousands of parsecs parallel to the rotation axis of the nucleus. The "fan jet" was formed during an explosion in the equatorial region of the nucleus, the duration of the explosion being $\sim\frac{1}{3}$ of a rotation period. The main portion of the gas in the coplanar "fan jet" is at present falling back into the nucleus. The halo of NGC 4486 can be explained by such "fan jets," and its apparent ellipticity is a consequence of its flatness. The masses of both jets are comparable and are of the order of 2 to $5 \cdot 10^6$ $M_\odot$. The question of the evolution of planetary nebulae ($\sim$3 $M_\odot$ per year) which form in NGC 4486 and have a low specific momentum is discussed. This gas cannot condense into stars and must of necessity fall onto the nucleus. This explains the emission for the very central region of NGC 4486. The total mass of the nucleus, which is $<10^9$ $M_\odot$, is estimated. Consequently the gas falling on the nucleus cannot accumulate there. The rotating plasma body which is formed in the nucleus in this manner must in the end explode, after which the process of formation of the plasma body begins anew. The energy released during the accretion of the gas injected by the stars into the nucleus is estimated and found to be $\sim 3 \cdot 10^{43}$ ergs/sec. It is hypothesized that the x-ray source in NGC 4486 may be a thermal source which is fed by accretion. (auth)

59532 INTERACTION OF PRIMORDIAL GRAVITATIONAL WAVES WITH GROUPS OF GALAXIES. Rees, M. J. (Harvard Coll. Observatory, Cambridge, Mass.). Mon. Notic. Roy. Astron. Soc.; 159: No. 3, 11P-13P(1972).

Two processes whereby very long wavelength gravitational waves may cumulatively feed energy into a cluster of galaxies during its lifetime are considered, and found to be unimportant. The only potentially observable manifestation of primordial gravitational radiation is the velocity dispersion induced by waves currently interacting with groups of galaxies, as discussed in a previous paper by the same author. (auth)

59533 GALACTIC ROTATION AND THE PRECESSION CONSTANT. Clube, S. V. M. (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Notic. Roy. Astron. Soc.; 159: No. 3, 289-314(1972).

The effect of high-proper-motion stars on the determination of the precession constant is discussed, and an improved technique of determining the stellar velocity field in the solar neighborhood is described. The technique is applied to stars in the FK4 and AGK3, and the results interpreted as implying an apparent rotation of the nearby stars in the opposite direction to galactic rotation. There is uncertainty in allowing for this counter-rotation, but a value of Oort's constant B in the region of $-1''.00$ per century is suggested. Only the distant Bo stars in the AGK3 seem consistent with a pattern of differential galactic rotation and a value of A in the region of $+0''.25$ per century is also suggested. Since evidence from other sources indicates that A is unlikely to be less than $-\frac{1}{2}$B, these determinations are probably still influenced, however, by the motions of nearby stars. The investigation provides general support for the kind of correction to the precession constant proposed by Fricke and Vasilevskis and Klemola, and implies that observation of the motion of the equinox is confused by a stellar component. (auth)

59534 HIGH FREQUENCY RADIO OBSERVATIONS OF OPTICALLY INTERACTING GALAXIES. Purton, C. R.; Wright, A. E. (York Univ., Toronto). Mon. Notic. Roy. Astron. Soc.; 159: No. 3, 15P-19P(1972).

Radio observations of four systems of gravitationally interacting galaxies are reported. It is concluded that no evidence of the interactions appears in the radio characteristics of the systems. (auth)

59535 INJECTION OF GRAINS INTO INTERSTELLAR CLOUDS. Wickramasinghe, N. C. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 159: No. 3, 269-87(1972).

Dust grains expelled from cool stars are injected into interstellar clouds with typical velocities of several thousand km s^{-1}. The interaction of such high speed grains with interstellar gas is discussed. Grains are shown to be preferentially stopped within gas clouds of number density $\eta_H \approx 10$ to 30 cm^{-3}, thus leading to the observed positive correlation between gas and dust. Impinging gas atoms, which have initial relative energies $\sim 10^2$ keV, produce several interesting effects. Grains are reduced in radius by a small factor due to sputtering, and the slowing of impinging atoms within grains leads to an initial heating of grains to temperatures $\sim$200°K and to the accumulation of solid-state defects. The displacement of defect concentration saturates at a value of $\sim$1%. The dissipation of the kinetic energy of grains within interstellar clouds could provide a major source of heating and ionization of such clouds. (auth)

59536 QUASARS AND THE NUCLEI OF GALAXIES: A SINGLE OBJECT OR A STAR CLUSTER. Bisnovatyi-Kogan, G. S.; Syunyaev, R. A. (Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 201-8(1972).

Translated from Astron. Zh.; 49: No. 2, 243-52(1972).

The stability of a gas—star system is investigated as a model for a quasar or the nucleus of a galaxy. Such a system cannot exist for an extended time, since the deceleration of normal stars in a dense gaseous medium results in a powerful energy release which leads to a luminosity far exceeding the critical luminosity. The presence of neutron stars or collapsed stars within an opaque gaseous object stabilizes a supermassive star and can extend its lifetime to $\sim 10^7$ years. The merits and inadequacies of two alternative models of the nuclei are critically analyzed: the model of a single gaseous object and the model of a compact star cluster. (auth)

59537 THEORETICAL MODELS OF PHOTOIONIZED INTERGALATIC HYDROGEN. Arons, Jonathan (Princeton Univ., N. J.); Wingert, David W. Astrophys. J.; 177: No. 1, 1-15(1 Oct 1972).

The effects of ionizing radiation emitted by quasi-stellar objects on intergalactic hydrogen are studied. The hydrogen is assumed to expand with the Universe, and the amount of ionizing radiation is estimated from observations of the QSO luminosity function. The discreteness of the radiation sources is taken into account in computing the thermal history of the medium. The amount of ionizing radiation is shown to be sufficient to allow the existence of a universal medium with a temperature less than 10^4°K and a density several times the smeared-out density of luminous matter in galaxies. Such a medium would escape detection with presently available techniques. (auth)

59538 VARIATION OF EMISSION-LINE STRENGTHS ACROSS M31. Rubin, Vera C.; Kumar, Krishna C.; Ford, Kent W. Jr. (Carnegie Institution of Washington, D. C.). Astrophys. J.; 177: No. 1, 31-44(1 Oct 1972).

Intensities of [N II] λ6584, [O III] λ5007, Hβ, and [S II] $\lambda\lambda$6717, and 6731 emission lines, relative to Hα, were measured for 53 H II regions between 3 and 24 kpc from the nucleus of M31. When these results are combined with earlier studies of the nucleus, it is shown that the [N II]/Hα line intensity ratio decreases systematically from a value of about 2 at the nucleus to about 0.2 at 15 kpc, beyond which distance there is no certain trend. A systematic increase in the [O III]/Hβ ratio from 0.4 to 2 is observed in going from 3 kpc to 15 kpc. The variations between 5 kpc and 15 kpc are interpreted as a decrease in the N/H and O/H abundance ratios by factors of 2 and 1.2, respectively, using a simplified model for the H II regions. Near $R = 5$ kpc, a group of H II regions exhibit anomalous spectra with very high excitation and strong lines, much like the nuclear spectra attributed to an excitation mechanism different from that of a conventional H II region. Overall, there is a similarity with line ratios for M33 and M101. (auth)

59539 SOME UNUSUAL SOUTHERN HEMISPHERE OBJECTS. Lue, Philip K. (Western Connecticut State Coll. Observatory, Danbury). Astron. J.; 76: No. 9, 775-6(Nov 1971).

Positions, finding charts, and descriptions are given for 40 unusual objects in the southern hemisphere. These unusual objects, which appear to be mostly peculiar galaxies or galactic nebulosities, were found from an examination of photographic plates taken with the 20-inch double astrograph of the Yale—Columbia Southern Observatory. (auth)

59540 GRAVITATIONAL PLASMAS. II. Severne, G. (Vrije Univ., Brussels). Physica; 61: No. 2, 307-13(15 Sep 1972).

The non-Markovian time evolution of a weakly coupled homogeneous gravitational system was shown by Prigogine and Severne to present a steady creation of correlation energy superposed upon a weakly oscillatory relaxation process. The discussion of the relaxation process introduced an approximation, and is reconsidered here. While some interesting modifications in detail appear, the overall behavior of the system is unchanged. (auth)

59541 270 pc EXPANDING RING AT THE GALACTIC CENTRE. Kaifu, N.; Kato, T.; Iguchi, T. (Tokyo Univ.). Nature (London) Phys. Sci.; 238: No. 85, 105-7(14 Aug 1972).

An analysis was made of previously published microwave spectroscopic data of the galactic center region, leading to the finding of an expanding ring of 270 pc radius and expansion and rotation velocities 130 and 50 km/S, respectively. Contour maps are shown for absorption of the 1,667 MHz OH line and the 6 cm formaldehyde absorption line, together with observed velocities of the peaks of the 1.3 cm ammonia lines, and also the H recombination lines of some H II regions. By fitting the velocity curve of the expanding and rotating ring to diagrams of OH absorption the above ring parameters were obtained. The thickness and width of the ring were estimated as ~70 pc. Particle density in the ring was estimated from the strength of the absorption lines of OH and formaldehyde, but values obtained were somewhat uncertain. It is considered that the ring could have expanded from the galactic center to its present radius in 2×10^6 years, if a constant expansion velocity of 130 km/S is assumed. This exceeds the velocity of sound in the region, and thus the expanding ring may be regarded as a shock front. The very high density and temperature in the shock front provide a good environment for the formation of molecules, and CO, HCN or other molecules may exist in the ring. The ring contains several H II regions and the dense molecular clouds. The existence of the 270 pc expanding ring and its outer expanding arms confirms recurrence of activity in the galactic center at intervals of 10^7 to 10^8 yr and the activity at the galactic center that caused the 270 pc expanding ring probably occurred $\sim 10^6$ yr ago, and its total energy exceeds 10^{56} to 10^{57} ergs. (UK)

59542 MOLECULES IN SPACE. Henderson, C. (Univ. of Aberdeen, Scotland). Contemp. Phys.; 13: No. 5, 479-99(Sep 1972).

The interstellar space of the spiral arms of the Galaxy contains dust clouds in which some 20 kinds of molecules are now known to exist. Many of the molecules are polyatomic. Only five years ago the general opinion was that such molecules could not survive the ultraviolet radiation thought to be present. At that time the diatomic CH, CH^+, and CN were known from the optical work of the 1930's, and the OH line had been studied for five years by radio telescopes. But in 1968 observation showed that the climate of interstellar space was not hostile to even fairly complex molecules. They are there within relatively cool dense clouds of molecular hydrogen that contains the dust particles whose surface may facilitate formation of the molecules, and whose presence certainly protects them from the ultraviolet radiation of stars. This review tells how the emission and absorption of spectral lines, revealing the presence of molecules, can also furnish estimates of their numbers, densities, and isotopic abundances. Departures from thermal equilibrium, including maser and reverse maser action, are mentioned. The radio telescopes and their spectrometers are described. (auth)

59543 OBSERVATIONS OF RADIO RECOMBINATION LINES. Brocklehurst, M.; Seaton, M. J. (University Coll., London). Comments At. Mol. Phys.; 3: No. 4, 113-20(Jul 1972).

In connection with the theory of radiative recombination and the recombination spectra of gaseous nebulae, some recent work on the interpretation of radio recombination line observations is discussed. In this connection stimulated emission is more important than true absorption, and in addition to line radiation the much stronger continuum radiation due to $H^+ + e \rightarrow H^+ + e + h\nu$ must be considered. In connection with line profiles the problem is to construct models for the nebulae which give agreement with observations of the absolute continuum intensity as a function of frequency, with the intensities of lines relative to the continuum, and with line profiles. In connection with the transfer problem optical depths can become large and an equation of radiative transfer must be solved in order to calculate the intensity of the emergent radiation. A model for the Orion Nebulae is described that gives good agreement with all radio observations which do not have high angular resolution. This model explains satisfactorily the following radio observations: the total continuum flux as a function of frequency, the line profiles, line to continuum ratios for $n\alpha$ lines, and the higher order lines. The model, however, is not entirely correct since both radio and optical observations of the nebula indicate the diameter to be about twice as large as that of the model. Work is in progress with the aim of constructing more realistic models. In connection with the observation of "anomalous lines", an unsolved problem concerns the calculation of electron-impact cross sections at lower energies. (UK)

Cosmology

Refer also to abstracts 59532, 59719, 59989, 59998, and 60004.

59544 ABUNDANCE OF HELIUM IN THE COSMOS. II. Hack, Margherita (Astronomical Observatory, Trieste, Italy). Sky Telesc.; 44: No. 4, 233-5(Oct 1972).

Observational data on helium abundance in young OB stars, old evolved stars, nebulae, the Sun, and other galaxies are reviewed. (W.D.M.)

59545 QUALITATIVE MAGNETIC COSMOLOGY. Collins, C. B. (Dept. of Applied Mathematics and Theoretical Physics, Cambridge, Eng.). Commun. Math. Phys.; 27: No. 1, 37-43 (1972).

The technique of phase plane analysis, which was used in a previous paper (Bihari, 1966) to study the behavior of a class of perfect-fluid anisotropic cosmological models, is applied to some simple anisotropic models that contain a uniform magnetic field. A formal correspondence is established between these magnetic models (Bianchi Type I) and certain perfect fluid models (Bianchi Type II), and new exact solutions are consequently discovered. (auth)

59546 DAMPING OF PREGALACTIC EDDY MOTION. Chibisov, G. V. (Moscow Physicotechnical Inst.). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 235-40(1972).

Translated from Astron. Zh.; 49: No. 2, 286-93(1972).

The damping of the eddy motion which is the source of pregalactic turbulence is calculated through an exact solution of the kinetic equation, taking account of radiative viscosity and friction for an arbitrary optical thickness $\tau \gtrsim 1$, for the model of a "hot" expanding universe. The main contribution to the damping comes from plasma recombination, which damps eddies having masses up to $10^{11.6}\ \Omega^{-1/2}\ M_\odot$. The small-scale eddy motion is reestablished after recombination if the eddy motion on the scale with which most of the energy is associated is not damped. This latter motion can be retained for values of the cosmological parameter Ω greater than 0.3; the combination of this condition with the condition that the relict-radiation spectrum be undistorted by turbulent heating leads to a prediction that Ω lies in the range 0.3 to 0.7. (auth)

59547 NON-UNIFORM RELATIVISTIC COSMOLOGICAL MODEL. Bonnor, W. B. (Queen Elizabeth Coll., London). Mon. Notic. Roy. Astron. Soc.; 159: No. 3, 261-8(1972).

The model is constructed to accommodate the variable cosmic density claimed by de Vaucouleurs. It is an exact solution of Einstein's equations for spherically symmetric dust flows, and is a special case of a class of solutions given by Tolman. The model has an imploding big bang, and evolves from extreme inhomogeneity to an eventual Einstein–de Sitter universe. It seems to be inconsistent with the observations of red shift—luminosity distance. (auth)

59548 ROTATIONAL PERTURBATIONS IN ANISOTROPIC COSMOLOGY. Ruban, V. A.; Chernin, A. D. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 363-4(1972).

Translated from Astron. Zh.; 49: No. 2, 447-9(1972).

In homogeneous cosmological models, small eddies grow during the vacuum Cazner stage of the anisotropic expansion of an ideal fluid with $P = \epsilon/3$. (auth)

59549 n-BODY PROBLEM WITH VARIABLE GRAVITATIONAL CONSTANT, AND SOME DYNAMICAL CONSEQUENCES FOR LARGE-SCALE COSMIC SYSTEMS. Omarov, T. B. (Inst. of Astrophysics, Alma-Ata, USSR). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 359-62(1972).

Translated from Astron. Zh.; 49: No. 2, 441-6(1972).

In connection with Jordan's work on the n-body problem and Dirac's concept of a time-dependent gravitational constant, attention is drawn to dynamical effects arising from the difference in initial conditions compared to the analogous classical problem in transformed space–time. On this basis the degree of spatial rarefaction of a gravitating system is determined such that either the velocities of the member bodies at the present epoch will exceed the oscillating escape velocity, or for members not having such high velocities the gravitational binding with all the other bodies will be negligible during a time interval including at least the life span of the system up to the present. Among the effects arising from the difference in initial conditions is the fact that a quasisteady gravitating system of specified mass in a universe with a weakening gravitation cannot possess linear dimensions of a scale such that the product of the size by the relative rate of change of G would much exceed the velocity dispersion. For Jordan's proposed value of the relative weakening of G at the present epoch, the results obtained are consistent with current views regarding supergalaxies and with the observed parameters of the largest galaxy clusters. (auth)

59550 KINETICS OF GRAVITATIONAL CLUSTERING. Saslaw, William C. (Univ. of Virginia, Charlottesville). Astrophys. J.; 177: No. 1, 17-29(1 Oct 1972).

Starting from Liouville's theorem and using the BBGKY hierarchy, general expressions are developed for the growth of correlations in isotropic systems of gravitating point particles. These are applied to investigate the early evolution of clusters and density fluctuations in an expanding universe. The timescale for the development of clustering can be considerably shorter than the timescale for the growth of linear hydrodynamic perturbations. This effect is caused by the graininess of the gravitational field. Successive stages of clustering to form galaxies, clusters of galaxies, and superclusters can occur in simple models of the Universe. The results also suggest a simple explanation for the observed secondary maxima of the density distributions within clusters of galaxies. (auth)

59551 HAMILTONIAN APPROACH TO THE DYNAMICS OF EXPANDING HOMOGENEOUS UNIVERSES IN THE BRANS–DICKE COSMOLOGY. Nariai, Hidekazu (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 6, 1824-43(Jun 1972).

In view of a grave importance of the problem of initial singularity in theoretical cosmology, the dynamical behavior of expanding homogeneous universes (without rotation) in the Brans-Dicke cosmology is studied by means of extending suitably the canonical formalism due to Arnowitt, Deser and Misner. It is shown that, even if the inertial (scalar) mode characteristic in their theory of gravitation is omitted, our Hamiltonian is somewhat different from Ryan's Hamiltonian in relativistic cosmology. This is due to the difference in the manipulation of the source (consisting of matter and radiation assumed as a perfect fluid whose total density and pressure are represented by ρ and p, respectively) Lagrangian, and it seems that our manipulation is superior to Ryan's. In spite of this, so far as $0 \leq p \leq \rho/3$, there exists an extremely early stage at which the source term in our Hamiltonian becomes negligible in such a way that it is reduced to a generalized version of Misner's Hamiltonian derivable from Ryan's under the same approximation. If $\rho/3 < p \leq \rho$, however, such a stage cannot exist because of some peculiar role of the inertial mode interacting with matter and radiation. Accordingly, the dynamical behavior of gravitational and inertial modes at the extremely early stage of both the Bianchi-type IX universe with $p = \rho/3$ and the Bianchi-type I universe with $p = \rho$ is analyzed in detail. The dynamical behavior is described as the three-dimensional motion of a world point in the presence of either the triangular potential walls (found by Misner) with gravitational origin or another potential field with inertial origin. It is shown in the former case that the inertial mode plays a significant role to modify Misner's bounce law for the collision of the world point with the potential walls, but is incompetent to eliminate the initial singularity of infinite density. On the other hand, in the latter case, the initial singularity may be formally removed under some condition which, however, contradicts with the requirement due to Brans-Dicke that the coupling constant ω must be larger than about 6. (auth)

59552 LIMIT ON THE ENERGY DENSITY IN THE SUBMILLIMETRE BACKGROUND RADIATION. Cowsik, R. (Univ. of California, Berkeley). Nature (London) Phys. Sci.; 239: No. 90, 41-2(18 Sep 1972).

Earlier work on this topic is discussed, together with an analysis of the data by the present author. (UK)

59553 RELATIVISTIC PRECESSIONS OF MACROSCOPIC OBJECTS. Whitmire, D. P. (Univ. of Texas, Austin). Nature (London); 239: No. 5369, 207(22 Sep 1972).

The problem of extending the Thomas precession to a macroscopic object spinning about its own axis has recently been considered in connection with a rapidly rotating disk. It was concluded that an arbitrary finite section of the disk would not undergo a Thomas rotation, but instead would experience "Thomas shear stresses" and that only the individual rigid units (point particles) would rotate with the Thomas precession rate. The chief aim of this communication is to point out that, if the gravitational field of the disk is not neglected, this result also holds for the analogous general relativistic precessions, and to re-examine the relativistic precessions from a more realistic microscopic point of view. (auth)

59554 POSITIVE SIGNATURE FOR THE RECOGNITION OF GRAVITATIONAL RADIATION. Burke, W. L. (Univ. of California, Santa Cruz). Nature (London) Phys. Sci.; 239: No. 90, 43(18 Sep 1972).

A method is suggested whereby the effects of gravitational waves (GW) driving an antenna system can be clearly separated from all other physical inputs. The method depends on the fact that for GW, and GW alone, the proper acceleration of the ends of the antenna and the proper strain in the elastic parts of the antenna are not exactly 90° out of phase. It is stated to be very important to have a positive signature for GW interaction; firstly because it will allow positive recognition of GW and a definite proof of its existence; secondly because it will allow detection of both GW and even purely random signals; and thirdly, because it will allow single antenna experiments, and thus open the way to using very large structures or even the entire Earth. For simplicity only the "canonical antenna" is considered, and attention is restricted to cases where (i) waves are weak (linearised theory of gravity); (ii) antenna motions are small; (iii) the antenna is smaller than a wavelength; (iv) the wave has linear polarization along the antenna, and (v) the wave is incident normal to the antenna. (UK)

59555 THEORETICAL BLACK-BODY RADIATION TEMPERATURE 2.2 K. Dodson, C. T. J. (Univ. of Lancaster, Eng.). Nature (London) Phys. Sci.; 239: No. 91, 64(25 Sep 1972).

It is stated that in the case of cosmological models of hyperbolic type Einstein equations in the homogeneous case these lead to the relationship $\mu \alpha t^{-2}$, for small values of t, and therefore $T \alpha t^{-\frac{1}{2}}$, and in particular T = 3,000°K at $t = 2.56 \times 10^{13}$ s. [t = time; μ = radiation density; T = temperature]. The temperature 3,000°K is significant since thereafter radiation suffers little absorption since electrons have been captured by nuclei, μ then declining only because of the expanding volume of space. From these results the present blackbody background temperature is calculated as 2.2°K, in agreement with revised observational values given by others. (UK)

59556 UNIT TRANSFORMATIONS AND COSMOLOGY. Lord, E. A. (Inst. of Mathematical Sciences, Madras). Nuovo Cim.; 11B: No. 2, 185-200(11 Oct 1972).

The mathematical consequences of the hypothesis that physical laws should be invariant under space–time-dependent changes in the unit of length are investigated. The hypothesis leads to the introduction of a scalar field and a vector field; the vector field enters the formalism in the same way as that of Weyl's geometry, with which it can be identified, but since it does not couple to spin-$\frac{1}{2}$ fields it is not interpretable as the electromagnetic potential. The theory obtained does not satisfy energy–momentum conservation and therefore allows creation of matter. The relationship between the conformally covariant theory and the cosmological theories of Hoyle and Narlikar and of Brans and Dicke is discussed. (auth)

Planetary Phenomena

Refer also to abstract 59508.

59557 EXCESS ARGON IN SUBMARINE BASALTS AND AN EARTH-ATMOSPHERE EVOLUTION MODEL. Ozima, M.; Kudo, K. (Tokyo Univ.). Nature (London) Phys. Sci.; 239: No. 89, 23-4(11 Sep 1972).

It is shown that determination of excess Ar in rock samples gives information on the isotopic ratios in the results, and that a reasonable Earth-atmosphere evolution model may be constructed from the data. (UK)

59558 PRELIMINARY STUDIES OF SOME APOLLO 14 LUNAR ROCKS. Cuttitta, Frank; Rose, H. J. Jr.; Annell, C. S.; (and others) (Geological Survey, Washington, D. C.). U. S. Geol. Surv., Prof. Pap.; No. 800-C, 189-93(1972).

The major-, minor-, and trace-element compositions of two igneous rocks, seven breccias, four microbreccias, and two breccia clasts collected from the Fra Mauro Formation by the Apollo 14 mission were determined by combined semimicro chemical, x-ray fluorescence, and optical emission spectrographic techniques. Photographic and optical microscopic examinations indicate that most of the Apollo 14 returned lunar materials are breccias. Preliminary evaluation of these elemental, photographic, and optical microscopic studies indicate that the Fra Mauro highland materials have the same nonterrestrial compositional character exhibited by the lunar maria (lowland) materials. All the lunar samples have a higher refractory-element content, lower volatile-element content, and greater reducing capacity than comparable terrestrial rocks. Compared to the maria breccias, the

Fra Mauro breccias are characterized by lower Fe/Ni, Cr/Ni, and Cr/V ratios and higher Ni/Co ratios. The Apollo 14 lunar samples are more complex mineralogically than the Apollo 11 and 12 materials, suggesting a different mode of formation. (auth)

59559 DISRUPTION OF THE SURFACE DUST MATRIX OF A COMET NUCLEUS. Dobrovol'skii, O. V.; Ibadinov, Kh. (Inst. of Astrophysics, Stalinabad, USSR). Dokl. Akad. Nauk Tadzh. SSR; 14: No. 12, 16-19(1971). (In Russian).

The analytical process of disruption of the porous dust matrix left by sublimation of ice from the surface of a comet nucleus was investigated. An expression was obtained for the surface disruption of the dust matrix involving its critical thickness, H_k. The value of H_k decreases with the comet's approach to the sun, and consequently the dimensions of the fragments of the matrix decrease as the fragments pass over into the comet's atmosphere. (K.S.W.)

59560 SPECTRAL STUDIES OF BENNETT'S COMET 1970 II (1969 i). Dobrovolskii, O. V.; Mamadov, O. (Inst. of Astrophysics, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 15: No. 4, 14-17(1972). (In Russian).

Normal and panchromatic film was used in taking the spectra of the comet discovered by John Bennett in 1969, with calibration of the film by means of an optical wedge and a spectrum of the moon. Five spectra were taken (March, April 1970). As the heliocentric distance of the comet increased, the intensity of CN decreased more rapidly than that of C_3, CH, and C_2. The spectrophotometric temperature and the spectral class of the comet were also periodically measured. (K.S.W.)

59561 OBSERVATIONS OF PLANETS, NEBULAE, AND GALAXIES AT 350 MICRONS. Harper, D. A. Jr. (Univ. of Chicago); Low, F. J.; Rieke, G. H.; Armstrong, K. R. Astrophys. J.; 177: No. 1, L21-5(1 Oct 1972).

Ground-based measurements have been made of the 350-μ flux from Venus, Mars, Jupiter, Saturn, Uranus, and the Orion Nebula. Upper limits were obtained for the flux from NGC 2024, NGC 1068, NGC 4151, and the galactic center. (auth)

59562 EXTENSIVE AIR SHOWERS ON JUPITER, AND ITS SPORADIC DECAMETER RADIO EMISSION. Vasil'ev, V. P.; Volovik, V. D.; Zalyubovskii, I. I. (Kharkov State Univ.). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 337-41(1972).

Translated from Astron. Zh.; 49: No. 2, 413-19(1972).

A new explanation is proposed for the origin of the sporadic radio emission of Jupiter, consistent with the main observational evidence on decameter bursts. The source of the radio bursts at all the frequencies observed is considered to be the coherent radio emission of extensive air showers, amplified in the planet's ionosphere. The radiation is intensified by a maser mechanism based on spin—electron transitions. The conditions giving rise to this intensification are produced by a reorientation of electron magnetic moments due to changes in the direction of the magnetic field in the ionosphere. These changes are associated with the motion through the ionosphere of the base of a magnetic field tube frozen into the satellite Io, and also with the reorganization of the magnetic field as the position of the north magnetic pole varies because of the rotation of Jupiter. (auth)

59563 MEASUREMENT OF JUPITER'S RADIO EMISSION AT 2.94 m. Artyukh, V. S.; Kuz'min, A. D.; Makarov, A. N. (Lebedev Physics Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 16: No. 2, 372-3(1972).

Translated from Astron. Zh.; 49: No. 2, 456-8(1972).

The planet Jupiter's radio emission at 102 MHz was measured. The brightness temperature, averaged over the visible disk, was found to be $3.8 \cdot 10^5$°K. (auth)

59564 SOLAR WIND OBSERVATIONS ON THE LUNAR SURFACE WITH THE APOLLO-12 ALSEP. Neugebauer, M.; Snyder, C. W.; Clay, D. R.; Goldstein, B. E. (California Inst. of Tech., Pasadena). Planet. Space Sci.; 20: No. 10, 1577-91(Oct 1972).

The Apollo-12 ALSEP solar wind spectrometer obtained data from the lunar surface starting November 20, 1969. To a first approximation, the general features of the positive ion flux depend only on the instrument's orientation and location in space relative to the Sun—Earth system. However, there are some detectable effects of the interaction of the solar wind with the local magnetic field and surface, including the deceleration of incident positive ions and the enhancement of fluctuations in the plasma. The expected asymmetry of sunset and sunrise times due to the motion of the Moon about the Sun is not observed. On one occasion, the solar wind was incident on the ALSEP site as early as 36 hr (18°) before sunrise. (auth)

59565 DATING OF MECHANICAL EVENTS BY DEFORMATION-INDUCED ERASURE OF PARTICLE TRACKS. Fleischer, R. L.; Comstock, G. M.; Hart, H. R. Jr. (General Electric Research and Development Center, Schenectady, N. Y.). J. Geophys. Res.; 77: No. 26, 5050-3(10 Sep 1972).

Natural fine-scale plastic deformation of lunar pyroxenes has been observed to fragment pre-existing charged-particle tracks. An observer using only an optical microscope would see only the tracks formed later and hence would measure the time when deformation occurred. In one sample the deformation was estimated to have occurred 20 to 25Myr ago. (auth)

59566 AVERAGE ^{130}Ba(n,γ) CROSS SECTION AND THE ORIGIN OF ^{131}Xe ON THE MOON. Kaiser, W. A. (Univ. of California, Berkeley); Berman, B. L. Earth Planet. Sci. Lett.; 15: No. 3, 320-4(Jul 1972).

The average ^{130}Ba(n,γ) cross section was measured for a neutron spectrum similar to the one at the lunar surface. The large cross section obtained probably explains the anomalously high concentration of ^{131}Xe found in the lunar rocks. (auth)

59567 PRELIMINARY STUDIES OF SIX APOLLO 14 LUNAR SOILS. Annell, C. S.; Carron, M. K.; Christian, R. P.; (and others) (Geological Survey, Washington, D. C.). U. S. Geol. Surv., Prof. Pap.; No. 800-C, 195-8(1972).

Major-, minor-, and trace-element analyses made by combined semimicro chemical, x-ray fluorescence, and optical emission spectrographic techniques are presented for six samples of lunar highland soil from the Fra Mauro Formation returned by the Apollo 14 mission. The analyzed soil samples are very similar in major-element chemical composition but show a possible bimodal distribution for Ni ($\approx$300 and >400 ppm), B(<10 and $\approx$18 ppm), and Nb($\approx$40 and $\approx$70 ppm). Compared to the Apollo 11 and 12 lunar maria soils, the Apollo 14 soil is characterized by higher content of Al_2O_3, Na_2O, and K_2O, and by lower FeO and TiO_2. This distribution is correlated with a higher observed percentage of feldspar in the Apollo 14 soil. The Apollo 14 soil has more Fe and Ni than the Apollo 14 basalts, which we interpret as indicating a meteorite component. (auth)

59568 URANIUM DISTRIBUTION IN BASALT FRAGMENTS OF FIVE LUNAR SAMPLES. Thiel, K.; Herr, W.; Becker, J. (Univ., Cologne). Earth Planet. Sci. Lett.; 16: No. 1, 31-44 (Sep 1972).

The U-distribution in selected basaltic fragments from lunar fines 10084, rocks 12021 and 12053, and breccias 14305 and 14321 was studied by means of fission tracks in mica detectors. U-enriched mineral phases were localized with an accuracy of better than 1 μm by applying a photographic mapping technique. Identification and elemental analysis were carried out using an electron microprobe. Phases of high U-content were identified as apatite (30 to 280 ppM), SiO_2-rich glasses (3 to 150 ppM) or fine-grained Zr-containing minerals of grain sizes < 1 μm (50 to 450 ppM). These U-enriched phases preferentially occur in the mesostasis. An inverse relationship was found between the U-concentration and the volume of the mesostasis regions. The ratio of the U-contents of the residual liquid and the major phases is comparable with that found in terrestrial basalts. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstract 58915.

59569 FIELD-STRENGTH MEASUREMENTS TAKEN IN CLUJ DURING THE PARTIAL SOLAR ECLIPSE OF FEBRUARY 25, 1971. Laszlo, T. I.; Lazar, G. Stud. Univ. Babes-Bolyai, Ser. Phys.; 17: No. 1, 87-90(1972).

Observations were made of the partial eclipse of Feb. 25, 1971 at Cluj, Romania. The greatest diurnal variations of electron concentration occur in the D region during solar eclipses. The response of the D region to absorption of the hf and mf electromagnetic waves crossing that region and the propagation of the lf and vlf waves reflected from it is normal during solar eclipses in relation to other regions. Each method of automatic recording of signal strength fails from difficulties associated with the rapid fading of the signal. An apparatus is described that integrates the signal amplitude over a time interval long in comparison with the fading period. After integration, the output signal is applied to a pen recorder and the recording represents the mean amplitude over the period of the integration, regardless of the momentary polarization state of the downcoming wave. The use of the differential dc amplifier with a Miller integrator is described. The procedure during the recording of the field-strength paths is delineated. (J.C.W.)

59570 PROPAGATION OF A NONGUIDED VLF WAVE NEAR THE MAXIMUM FREQUENCY OF THE LOWER HYBRID RESONANCE. Charcosset, Guy (Univ., Poitiers, France). Compt. Rend., Ser. B; 275: No. 2, 113-15(10 Jul 1972). (In French).

The propagation of a nonguided descending radiowave in the magnetosphere was studied. It is shown that if the electron density of the medium is sufficiently low, and the wave frequency is lower than a maximal lower-hybrid resonance frequency of 10.67 kHz, the wave is not reflected. (France)

59571 DIURNAL VARIATIONS AND HYDROGEN AND OXYGEN CONSTITUENTS IN THE MESOSPHERE AND LOWER THERMOSPHERE. Thomas, L.; Bowman, M. R. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys.; 34: No. 11, 1843-58(Nov 1972).

Time-dependent solutions of the diffusion and continuity equations are used to examine the diurnal variations of constituents in an oxygen—hydrogen atmosphere. Account is taken of recent revisions in solar-flux data, predissociation of molecular oxygen in the Schumann—Runge bands, and experimental data on the height variation of the eddy-diffusion coefficient. The results for $O(^3P)$, O_2, O_3 and $O_2(^1\Delta_g)$ are compared with experimentally determined concentrations. (auth)

59572 CHANGES OF LOWER IONOSPHERE ELECTRON CONCENTRATIONS WITH SOLAR ACTIVITY. Mechtly, E. A. (Univ. of Illinois, Urbana); Bowhill, S. A.; Smith, L. G. J. Atmos. Terrest. Phys.; 34: No. 11, 1899-1907(Nov 1972).

During Sunspot Cycle No. 20, the University of Illinois and the GCA Corporation measured electron concentrations in the lower ionosphere (55 to 95 km altitude) above Wallops Island, Virginia, by 10 Nike Apache rockets at solar zenith angles of about 60°. Five were flown during quiet-Sun conditions (April to December 1965), and five during active-Sun conditions (July 1968 to September 1969). Numerical values are given for the measured electron concentrations, and a simple four-parameter model is presented that adequately describes the leading features of the height profiles. Median-value profiles are presented for quiet- and active-Sun conditions and are recommended for use in theoretical studies. (auth)

59573 PROBE MEASUREMENTS OF POSITIVE IONS AND ELECTRON TEMPERATURES IN HIGH LATITUDE ROCKET FLIGHTS. Folkestad, K. (Institutt for Atomenergi, Kjeller, Norway). J. Atmos. Terrest. Phys.; 34: No. 11, 1935-9(Nov 1972).

Ion densities and electron temperatures were measured in two high-latitude rocket flights. Main features are briefly discussed in terms of differing solar zenith angles, interaction of low-energy particles, and the possible influence of magnetospheric heat sources. (auth)

59574 GRAVITY WAVES IN THE ATMOSPHERE. Hines, C. O. (Univ. of Toronto). Nature (London); 239: No. 5367, 73-8(8 Sep 1972).

Atmospheric gravity waves similar to waves that occur on the surface of a body of water have been known since the nineteenth century, but their significance for the study of atmospheric dynamics has been realized only in the past ten years. (auth)

59575 THEORETICAL MODELS OF THE D-REGION. Sechrist, C. F. (Univ. of Illinois, Urbana). J. Atmos. Terrest. Phys.; 34: No. 10, 1565-89(Oct 1972).

Much progress has been made in recent years in the development of theoretical models of minor neutral constituents, which include the effects of transport. Important sources of ion-pair production continue to be photoionization of O_2 and N_2 by x rays, photoionization of NO by Lyman-alpha, and ionization of O_2 and N_2 by galactic cosmic rays. Photoionization of $O_2(^1\Delta)$ by solar uv is less important than thought originally. Ironically, the positive-ion chemistry in the disturbed high-latitude D region appears to be understood better than that in the undisturbed D region. Tentative positive-ion and negative-ion models of the undisturbed, midlatitude D region exist, but there are several problems. Also, attempts have been made to model D-region ionization for the sunrise transition. It is concluded that the true ambient composition and concentration of minor neutral constituents and positive and negative ions must be accurately measured before meaningful theoretical model studies can proceed. (auth)

59576 RELATIONSHIP OF THEORY AND EXPERIMENT IN THE D-REGION. Aikin, A. C. (Goddard Space Flight Center, Greenbelt, Md.). J. Atmos. Terrest. Phys.; 34: No. 10, 1591-9(Oct 1972).

For any physical system, an effort is made to monitor its descriptive parameters and construct a model that predicts their temporal and spatial variations. This is a particularly difficult task for the lower ionosphere. In a given situation simultaneous measurements should be conducted of ionization sources, the altitude distribution of all neutral atmospheric constituents, the identification, number density, and altitude distribution of different species of positive and negative ions and electrons. These results are compared with theoretical predictions to serve as boundary conditions and guides to modification of the theory. It has not been possible to realize this goal in lower ionosphere research because of the large number of parameters and since certain parameters, as for example, positive-ion species distribution and nitric oxide, can only be measured with the aid of sounding rockets. To illustrate the difficulty, recent positive-ion composition measurements are compared with predictions utilizing clustering of ions and neutrals to form hydrated ions. (auth)

59577 E-REGION MODEL PARAMETERS. Swider, W. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Atmos. Terrest. Phys.; 34: No. 10, 1615-26(Oct 1972).

The formation of any E-region model is dependent upon a number of key parameters, some of which are reviewed. Particular emphasis is placed on the mean dissociative recombination coefficient of the E region, α_M, the most important E-region parameter. It appears that 3×10^{-7} (300/T)cm^3 sec^{-1} is a reasonable value for α_M, based on laboratory measurements. Ionospheric studies yield α_E, the effective recombination coefficient of the E region, the deduction of which appears to have suffered from various inadequacies in the past. While normally $\alpha_E = \alpha_M$, it is shown how they sometimes differ. Ionization of NO by the direct Lyman-α flux is significant at twilight, and ionization of NO by scattered Lyman α is important below about 100 km at night. The E region above 100 km at night is apparently maintained by Lyman β. The interrelationships between α_E,α_M,NO, Lyman α, and Lyman β during night and twilight are stressed. Electron precipitation is not thought to be a common source of the midlatitude night-time E region, and it is demonstrated how the presence of a night-time meteor ion layer can lead to erroneous conclusions concerning the source. The influence of transport is briefly discussed, as well as some effects of the O/O_2 ratio. (auth)

59578 DEVELOPMENT OF A THEORETICAL MODEL OF THE ATMOSPHERE AND THE IONOSPHERE. Chandra, S. (Goddard Space Flight Center, Greenbelt, Md.); Stubbe, P. J. Atmos Terrest. Phys.; 34: No. 10, 1627-33(Oct 1972).

The theoretical models of the neutral atmosphere and the ionosphere in the altitude range of 120 to 1500 km are discussed for specified solar flux and boundary conditions. These models are based on the solution of the time-dependent ionospheric and atmospheric equations and provide basis for constructing self-consistent theoretical models for the ion and the neutral composition and their temperatures in the thermospheric region. Numerical examples are presented for diurnal variations of the basic parameters of the ionospheric plasma for different sets of boundary conditions. The physical implications of using constant and variable boundaries in constructing theoretical models are discussed. (auth)

59579 AURORAL IONOSPHERE MODELS. Walker, J. K. (Dept. Energy, Mines, and Resources, Ottawa). J. Atmos. Terrest. Phys.; 34: No. 10, 1681-9(Oct 1972).

The electron-density height profile in an auroral arc is calculated for equilibrium conditions from the electron continuity equation. The ionization production rate and the loss by dissociative recombination in the continuity equation are taken from observations of BRYANT et al. (J. Atmosph. Terr. Phys., 32; 1695 (1970)) while the ion-atom recombination loss rate was calculated from QUINN and NISBET (J. Geophys. Res., 70; 113 (1965)). Loss by diffusion along the magnetic-field lines and across the arc was also determined for a typical auroral arc. Equilibrium of the electron density was obtained approximately 20 sec after the ionization rate was increased 10 times. The peak electron density in the auroral E-region is related to the volume emission of $\lambda5577$. An empirical expression relating the peak auroral brightness and the height profile of the electron density is developed. Auroral-zone cross sections of the electron density are constructed from the electron-density profiles. (auth)

59580 THREE-DIMENSIONAL MODEL OF THERMOSPHERE DYNAMICS. 1. HEAT INPUT AND EIGENFUNCTIONS. Volland, H. (Univ., Bonn). J. Atmos. Terrest. Phys.; 34: No. 10, 1745-68(Oct 1972).

A three-dimensional model of thermosphere dynamics is developed in terms of the eigenfunctions of the atmospheric system. Formulae for the external heat inputs like solar xuv radiation and corpuscular heating during geomagnetic storms are derived in terms of these eigenfunctions. Those series contain tidal components (depending on local time) and planetary components (depending on seasonal time) that are the generators of tidal and planetary neutral atmospheric waves. The relative importance of corpuscular heating when compared with xuv heating is estimated. Approximate analytic solutions for the generation and propagation of the atmospheric waves within the dissipative thermosphere excited by the solar heat input are given. It is shown that the eigenfunctions that are the Hough functions within the nondissipative lower atmosphere change into the spherical surface functions within the dissipative thermosphere. Moreover, the density amplitudes of the wave modes decrease proportional to $1/n^2$ where n is the zonal wave domain number of the spherical harmonics. Therefore, only the wave modes with low wave domain numbers n are significant at thermospheric heights. (auth)

59581 THREE-DIMENSIONAL MODEL OF THERMOSPHERE DYNAMICS. 2. TIDAL WAVES. Volland, H. (Univ., Bonn); Mayr, H. G. J. Atmos. Terrest. Phys.; 34: No. 10, 1769-96 (Oct 1972).

The generation and the propagation of three fundamental tidal modes—the symmetric diurnal mode, the symmetric semidiurnal mode, and the antisymmetric diurnal mode—were studied, based on a theory outlined previously (Volland and Mayr, J. Atmos. Terrest. Phys., 34; 1745 (1972)). The equivalent depths of these modes and the eigenfunctions that describe the latitudinal pressure structure of the modes change with altitude. While within the lower atmosphere the eigenfunctions are the Hough function; they transfer into the ordinary spherical functions at thermospheric heights. The transition range is between 100 and 200 km. Horizontal winds and pressure amplitudes of the three modes, depending on altitude and latitude, were determined and compared with available wind and density data. (auth)

59582 THREE-DIMENSIONAL MODEL OF THERMOSPHERE DYNAMICS. 3. PLANETARY WAVES. Volland, H. (Univ., Bonn); Mayr, H. G. J. Atmos. Terrest. Phys.; 34: No. 10, 1797-1816(Oct 1972).

Calculations are made for the generation and propagation of atmospheric waves of planetary scale with zonal wave domain numbers $n = 1,2,3$, and 4 within the dissipative thermosphere. These waves are generated by solar xuv heat input and by corpuscular heating of the thermosphere. They contain time-independent zonal components and annual and semiannual components. The latitudinal structure of their eigenfunctions and the height variation of this structure are determined. It is shown that the relative pressure amplitudes of the wave modes approach asymptotic values at high altitudes that are proportional to $1/n(n + 1)$. Therefore, the thermosphere behaves like a filter, suppressing the waves with great wave domain numbers n. The corresponding wind and pressure systems of the various wave modes are determined and compared with observed wind data at mesospheric heights, as well as with density data derived from satellite drag observations. It is shown that the predominant annual component with wave number $n = 1$ is generated by the surplus of solar radiation on the summer hemisphere within the entire atmosphere and that the semiannual component containing mainly the wave mode of number $n = 4$ is generated by corpuscular heat input within the auroral ovals. (auth)

Particle Kinetics and Trapping

59583 SATELLITE MEASUREMENTS OF HIGH-LATITUDE CONVECTION ELECTRIC FIELDS. Cauffman, David P.; Gurnett, Donald A. (Univ. of Iowa, Iowa City). Space Sci. Rev.; 13: No. 3, 369-410(Jul 1972).

The first results of satellite experiments to measure magnetospheric convection electric fields using the double-probe technique are reviewed. The earliest successful measurements were made with low-altitude (680 to 2530 km) polar orbiting Injun-5 spacecraft (launched August, 1968). The Injun-5 data are discussed in detail. The Injun-5 results are compared with the initial findings of the electric-field experiment on the polar orbiting OGO-6 satellite (400 to 1100 km, launched June, 1969). In addition to electric fields, the Injun-5 spacecraft also measures electric antenna impedance and thermal and energetic charged-particle densities. Errors attributed to sunlight shadows on the probes, wake effects, and other factors are discussed. Reversals in the electric field at auroral-zone latitudes are the most significant convection electric-field effect discovered in the Injun-5 data. Electric-field magnitudes of typically 30 mV m^{-1}, and sometimes 100 mV m^{-1}, are associated with reversals. Electric field reversals occur on ~36% of auroral-zones traversals, at about 70 to 80° invariant latitude, at all local times, and in both hemispheres. The latitude of a reversal often changes markedly on time scales less than 2 h. Electric potentials of greater than 40 keV are associated with these high latitude electric fields. Reversals occur at the boundary of measurable intensities of >45 keV electrons and are coincident with inverted "V" type low energy electron precipitation events. In almost all cases the $E \times B/B^2$ plasma convection velocities associated with reversals are directed east or west, with anti-sunward components at higher latitudes and sunward components at lower latitudes. Maximum convection velocities are typically ~1.5 km s^{-1} and ordinarily occur at the auroral zone near the reversal. Two extreme (and many intermediate) configurations of anti-sunward plasma convection have been observed to occur on the high latitude side of electric field reversals. A summary pattern of >0.75 km s^{-1} polar thermal plasma convection is presented. The OGO-6 detector revealed the persistent occurrence of anti-sunward convection across the polar cap region at velocities (<0.75 km s^{-1}) not generally detectable with the Injun-5 experiment. The OGO-6 observations also provided information indicating that the location of the electric field reversal shifts equatorward during periods of increased magnetic activity. The implications of the electric field measurements for magnetospheric and auroral structure are summarized, and a list of specific recommendations for improving future experiments is presented. (48 references) (auth)

59584 FLUCTUATING MAGNETIC FIELDS IN THE MAGNETOSPHERE. II. ULF WAVES. McPherron, R. L.; Russell, C. T.; Coleman, P. J. Jr. (Univ. of California, Los Angeles). Space Sci. Rev.; 13: No. 3, 411-54(Jul 1972).

The study of ulf waves in space has been in progress for about 12 years. However, because of numerous observational difficulties the properties of the waves in this frequency band (10^{-3} to 1 Hz) are poorly known. These difficulties include the nature of satellite orbits, telemetry limitations on magnetometer frequency response, and compromises between dynamic range and resolution. Despite the paucity of information, there is increasing recognition of the importance of these measurements in magnetospheric processes. The roles such waves play in the dynamic behavior of radiation-belt particles are discussed. At the present time the existing satellite observations of ulf waves suggest that the level of geomagnetic activity controls the types of waves that occur within the magnetosphere. Consequently, quiet times, times of magnetospheric substorms, and times of magnetic storms are considered separately. Within each of these categories there are distinctly different wave modes distinguished by their polarization: either transverse or parallel to the ambient field. In addition, these wave phenomena occur in distinct frequency bands. In terms of the standard nomenclature of ground micropulsation studies, ulf wave types observed in the magnetosphere include: quiet time transverse, Pc 1, Pc 3, Pc 4, and Pc 5; quiet-time compressional, Pc 1 and Pi 1; substorm compressional, Pi 1 and Pi 2; storm transverse, Pc 1; and storm compressional, Pc 4, 5. The satellite observations are not yet sufficient to determine whether the various bands identified in the ground data are equally appropriate in space. (67 references) (auth)

Solar Wind and Cosmic Ray Interactions

59585 RELATIONSHIP BETWEEN THE VARIOUS INDICES OF GEOMAGNETIC ACTIVITY AND THE INTERPLANETARY PLASMA PARAMETERS. Kane, R. P. (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys.; 34: No. 11, 1941-3(Nov 1972).

A summary is given of the geomagnetic indices (A_p(or K_p), AN, AS, AM (for the northern and southern hemispheres and their mean), AE (the "auroral electrojet" indices) and ΔD_{st} (the difference between the highest and lowest values of the isotropic D_{st} in the course of a day)) and their correlations with the interplanetary plasma parameters (solar-wind velocity V, particle density N, interplanetary magnetic-field components B_x, B_y, B_z and their standard deviations σ_{B_x}, σ_{B_y}, σ_{B_z}). It is concluded that the indices are due to different dynamical processes occurring during the interaction of the planetary plasma parameters with the magnetosphere. (UK)

PHYSICS (ATOMIC AND MOLECULAR)

59586 ATOM. Golicki, Patrick. pp 32-80 of Physics. Paris; Centre d'Etude et de Promotion de la Lecture (1971). (In French).

A general introduction to the properties of atoms, nuclei, radioactivity, nuclear reactions, fission, and fusion is given. (France)

59587 DIRAC: DYNAMIC INFORMATION RETRIEVAL OF ATOMIC CODES. I. PHYSICAL DESIGN CRITERIA. Davies, Alan R.; Smith, Kenneth; Kwok, K. L. (Univ. of Nebraska, Lincoln). Comput. Phys. Commun.; 3: No. 4, 277-95(Jul 1972).

A computer code, acronym DIRAC, to assist atomic physicists to control and process a library of computer codes is described. The objectives of DIRAC are to facilitate the preparation of input, the storage of output within the computer's memory hierarchy, and the comparative analysis of results of the codes from the library. At the present time, the library consists of codes for calculating electron and photon processes in atomic systems within L−S coupling. Library members can be used to identify and store experimental results. The DIRAC system is based on the availability of an interactive graphics device and has been implemented on IBM-2250's attached to either the IBM System 360/65 or 360/91. (auth)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstract 60368.

59588 (ORO–3771-4) RECOMBINATION OF POSITIVE IONS WITH ELECTRONS IN GASES. Final Report, April 1, 1968–March 31, 1972. Franklin, J. L.; Brooks, P. R. (Rice Univ., Houston, Tex.). 1972. Contract AT(40-1)-3771. 6p. Dep. NTIS.

In order to study the recombination of positive ions with electrons to yield excited neutrals that would dissociate, a molecular beam apparatus was constructed in which a beam of ions could be crossed by a beam of electrons. The resulting neutrals could be detected by means of a quadrupole mass spectrometer. Extremely high ion and electron beam currents are required at low energies. Since these requirements are almost mutually exclusive because of space charge limitations, much effort went into testing (and discarding) ion sources. A temporarily satisfactory source was developed and re-ionized neutral fragments were observed. (auth)

59589 ANISOTROPY IN THE SECONDARY EMISSION PROPERTIES OF SINGLE CRYSTALS WHEN SCANNED BY AN ELECTRON BEAM. Korablev, V. V.; Ionov, V. V. (Leningrad Polytechnic Inst.). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 3, 692-5(Sep 1972).

Translated from Fiz. Tverd. Tela; 14: No. 3, 811-15(Mar 1972).

The results of experimental investigations of anisotropy in the secondary-emission properties of silicon and molybdenum single crystals using a raster method with modulation of the deflection are reported. Measurements were carried out for various primary electron energies and the sample temperature was varied. The main results of the investigation agree with those obtained with rotation of the target relative to a fixed electron beam. The observed pseudo-Kikuchi lines can be used to determine the orientation of single-crystal samples relative to the electron beam directly in the experimental apparatus. (auth)

59590 ENERGY DISTRIBUTION OF TRANSMITTED SECONDARY ELECTRONS FROM POROUS KCl FILMS. Ito, Hideo; Yoshida, Shigetomo (Tohoku Univ., Sendai). Jap. J. Appl. Phys.; 11: No. 10, 1454-9(Oct 1972).

The energy distribution of transmitted secondary electrons from porous KCl films was measured by an ac-retarding field method. The surface potential of the films was obtained from the peak position of this energy distribution. There were three distinct regions in the behavior of the secondary emission according to the surface potential and its distribution. In Region 1 the distribution range of the surface potential was quite small, and the yield increased exponentially with the surface potential. In Region 2 the distribution range of the surface potential increased rapidly with the collector voltage, and the energy distribution of emitted electrons broadened. In Region 3 the energy distribution curve had approximately a Gaussian shape and seemed to be determined almost entirely by the distribution of the surface potential. A mechanism of the energy distribution was proposed using a channel electron multiplier model. (auth)

59591 WAVES IN A VARIABLE-VELOCITY ELECTRON BEAM. Buts, V. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 559-63(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 709-15(Apr 1972).

The electromagnetic oscillations in a uniform unbounded electron beam moving with a time-dependent velocity $v_0 = v_0(t)$ are analyzed. It is shown that both longitudinal and transverse waves propagating at an angle to the direction of motion of the beam are unstable. The frequency of the longitudinal oscillations varies in proportion to the varying velocity of the beam. The conditions under which the frequency of the transverse oscillations can vary are derived. (auth)

59592 PULSED SOURCE OF NEGATIVE HYDROGEN IONS. Abroyan, M. A.; Nalivaiko, G. A.; Tsepakin, S. G. (Scientific-Research Inst. of Electrophysical Equipment, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 690-3(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 876-9(Apr 1972).

A high-current pulsed duoplasmatron from which negative hydrogen ions are extracted is described. The ion extraction occurs at the periphery of the plasma. The dependence of the yield of H_1^- ions on the discharge current, the pressure, the magnetic field, and the magnitude of the displacement of the axis of the emission aperture with respect to the axis of the discharge are investigated. A displacement of 2 mm is found to be optimum (for the given source) with respect to the current density of H_1^- ions and the ratio of the ion current to electron current. The operation of the source has been investigated with continuous gas feed. Beams of H_1^- ions with a current larger than 2 mA are obtained from the source with the diameter of the emission aperture equal to 1.5 mm. The normalized emittance is less than 0.07 mrad · cm for a beam current of 1 mA. (auth)

59593 HIGHLY FORCE-FREE RELATIVISTIC ELECTRON BEAM EQUILIBRIUM. Kan, J. R. (Dartmouth Coll., Hanover, N. H.); Lai, Hon-ming. Phys. Fluids; 15: No. 11, 2041-5(Nov 1972).

A nonhollowed-out relativistic electron beam model is considered in which the axial current well exceeds the Alfvén limit when the field-configuration of the beam is highly force free. In this model, the current has an axial as well as an azimuthal component. For a given ratio of these two current components, a family of solutions is obtained in which there is an upper limit on beam radius. Over a large range of the beam radius, the axial current in the model is large compared with the current carried by a beam of the same radius in Hammer and Rostoker's model. (auth)

59594 MEASUREMENT OF SPECTRAL–ANGULAR DISTRIBUTION OF BACKSCATTERED ELECTRONS. Gruzin, P. L.; Petrikin, Yu. V.; Rodin, A. M. At. Energ. (USSR); 33: No. 3, 779-81(Sep 1972). (In Russian).

Backscattering of 0.15- to 1.5-MeV electrons by semi-infinite targets of Al, Cu, Sn, Pb, and U was measured while the angle between the detector axis and the perpendicular to the target was maintained at 15, 30, 45, 65, and 80°. Differential backscattering coefficients were calculated for the five target metals at the five angles listed. The experimental equipment is briefly described and the probable errors of determination are discussed. (K.S.W.)

59595 EVIDENCE OF ANOMALOUS Z_1 DEPENDENCE OF INTERACTION POTENTIAL BY MULTIPLE SCATTERING EXPERIMENTS. Krygel, P.; Lippold, J.; Schwabe, S. (Humboldt Univ., Berlin). Phys. Status Solidi (b); 53: No. 1, 255-60(1 Sep 1972).

On the basis of Meyer's theory of multiple scattering, the collision parameters that substantially influence the scattering distribution are estimated. For reduced thicknesses of $\tau \leqq 2$, higher values of collision parameters around $p \geqq 2a$ (a screening parameter) have an influence on the scattering distribution. Experiments with various ions on carbon targets seem to show deviations of the half-width from the theoretical dependence on the atomic number. These deviations are interpreted by means of periodic fluctuations in the interaction potential, which have been shown experimentally by Nelson, and theoretically by Cheshire and Poate. (auth)

59596 MOLECULAR STRUCTURE EFFECTS OF ALUMINUM $K\beta$ X-RAY SPECTRA PRODUCED IN PROTON AND ALPHA-PARTICLE EXCITATION. Richard, P.; Bolger, J.; Olsen, D. K.; Moore, C. F. (Univ. of Texas, Austin). Phys. Lett.; 41A: No. 3, 269-71(25 Sep 1972).

Targets of Al and Al_2O_3 were bombarded by 0.8-MeV protons and 3.2-MeV alpha particles and the subsequent x-ray yield was measured. The $K\alpha$ x-ray spectra of Al and Al_2O_3 show fairly good agreement in both the proton and alpha-induced spectra; however, the structure in the Kβ x-ray spectra deviate from one another in both cases. These results are interpreted as effects due to the chemical bonding of the oxygen atoms to aluminum. (auth)

59597 SCATTERING IN A MOLECULAR BEAM AS A RESULT OF INTRABEAM COLLISIONS. Meschi, David J. (Univ. of California, Berkeley). J. Phys. Chem.; 76: No. 21, 2947-50(12 Oct 1972).

Collisions between molecules in a molecular beam can be a more serious cause of scattering than collisions of the beam molecules with a background gas. The magnitude of this effect is species dependent and is capable of influencing experimental results, as is shown by means of examples from high-temperature mass spectrometry. (auth)

Atomic and Molecular Properties

Refer also to abstracts 59668, 60381, and 60509.

59598 NUCLEAR-MOTION CORRECTIONS TO THE FINE STRUCTURE OF HELIUM. Douglas, Marvin (Univ. of California, San Diego, La Jolla). Phys. Rev. A; 6: No. 5, 1929-32 (Nov 1972).

The motion of the nucleus yields numerically important order m/M_{He} corrections to the fine structure of the helium atom. The derivation of such corrections applied to the 2^3P fine-structure splittings in ^4He is presented here. (auth)

59599 PROJECTION-OPERATOR APPROXIMATION FOR AUTOIONIZATION STATES IN THE INELASTIC SCATTERING REGION. Chung, Kwong T. (North Carolina State Univ., Raleigh). Phys. Rev. A; 6: No. 5, 1809-13(Nov 1972).

A projection-operator technique is used to investigate the resonance states of two-electron systems in the inelastic scattering energy region. Computations are carried out for the P autoionization states for He and the H^- ion in the n = 2 to n = 3 energy region. The results are compared with previous calculations and experiments. For the ^1P resonance of He, very good agreement is obtained as compared with the accurate measurement of Madden and Codling. (auth)

59600 SEMICLASSICAL THEORY FOR MOLECULAR AUTOIONIZATION. II. CLASSICAL TREATMENT OF THE RYDBERG ELECTRON. Ritchie, Burke (Univ. of Alabama, University). Phys. Rev. A; 6: No. 5, 1761-4(Nov 1972).

The spontaneous ionization of molecular Rydberg states by vibrational–translational or rotational–translational conversion results in electrons ejected with close to zero energy. This condition means that, without serious initial-final trajectory discrepancies, the Rydberg electron can be treated to a good approximation as a classical object, moving in a closed Kepler orbit, calculated in the Coulomb potential located at the center of mass of the molecular ionic core. The interactions that produce ionization are the monopole contributions of the nuclei in the region between the inner turning point and the radius of the ionic core, $R_1 \leq R \leq m_2/(m_1 + m_2)X$, and the multipole moment and polarization potentials in the region between the core radius and the outer turning point, $m_2/(m_1 + m_2)X \leq R \leq R_0$, plus additional interactions from the short-ranged part of the Hartree potential in both regions. The rate of ejection is given by the probability of ejection per period times the inverse period, $P(i \rightarrow j)\tau^{-1}$, for i, j rotational–vibrational states. τ^{-1} is proportioned to n^{-3}, where n is the principal quantum number of the Rydberg electron; thus the product $P\tau^{-1}$ obeys the "propensity" rule for multi-quantum-mechanical vibrational transitions and the n^{-3} rule deduced from the normalization of Rydberg states in fully quantum-mechanical treatments. Rates for H_2 are calculated in the Born and two-state approximations and compared with experimental and other theoretical results. (auth)

59601 INTERPRETATION OF PHOTOABSORPTION IN THE VICINITY OF THE 3d EDGES IN La, Er, AND Tm. Sugar, Jack (National Bureau of Standards, Washington, D. C.). Phys. Rev. A; 6: No. 5, 1764-7(Nov 1972).

Line spectra at the 3d photoabsorption edges of La, Er, and Tm are interpreted as transitions of the type $3d^{10}4f^N \rightarrow 3d^94f^{N+1}$. Calculated relative gf values for these transitions are compared with published absorption curves. (auth)

59602 HYPERFINE-STRUCTURE CONSTANTS AND g_J VALUES OF $^5I_{4,5,6,7,8}$ ATOMIC STATES OF $^{143,145}Nd$. Childs, W. J.; Goodman, L. S. (Argonne National Lab., Ill.). Phys. Rev. A; 6: No. 5, 1772-86(Nov. 1972).

The atomic-beam magnetic-resonance technique was used to extend the hyperfine-structure and g-value results of Smith and Spalding to all five members of the $4f^46s^2$ ^5I ground multiplet of $^{143,145}Nd$. The eigenvectors derived by Conway and Wybourne by fitting the excitation energies are reasonably consistent with the new data. The extent to which the hfs is affected by small components in the eigenvectors is investigated. Empirical values for the radial integrals that appear in the hyperfine structure are compared with predictions based on nonrelativistic Hartree–Fock and on relativistic Hartree–Fock–Slater calculations. The empirical value found for the dipole integral least susceptible to distortion by configuration interaction is within (1 to 3)% of the value calculated relativistically. Differences between theory and experiment are substantial for some of the other integrals, however. The values of the electric-quadrupole moments of $^{143,145}Nd$ are found to be –0.56(6) b and –0.29(3) b, respectively. (auth)

59603 MULTIPHOTON IONIZATION OF HYDROGEN ATOMS IN THE SEMICLASSICAL TREATMENT OF AN INTENSE RADIATION FIELD. Tewari, Surya P. (Univ. of Delhi). Phys. Rev. A; 6: No. 5, 1869-75(Nov 1972).

The transition probability for the multiphoton ionization of the ground-state hydrogen atom by an intense electromagnetic field was calculated following a nonperturbative method developed by Reiss. One distinctive feature of the calculation is a minor reduction in the power-law dependence of the interaction parameter in the transition probability. (auth)

59604 PREDISSOCIATION OF H_2 AND D_2 ($D^1\Pi_u$): COMPARISON OF CALCULATED AND EXPERIMENTAL LINE-WIDTHS. Fiquet-Fayard, F.; Gallais, O. (Paris Univ., Orsay, France). Chem. Phys. Lett.; 16: No. 1, 18-19(15 Sep 1972).

The agreement between recalculated and experimental line-widths for the vibrational levels of H_2 and D_2 ($D^1\Pi_u$) is within 30%. (auth)

59605 METALLIC RADIUS OF ACTINIUM. Hill, H. Hunter (Los Alamos Scientific Lab., N. Mex.). Chem. Phys. Lett.; 16: No. 1, 114-18(15 Sep 1972).

An interpretation of existing atomic calculations makes plausible the unusual relationship between the empirical metallic radii of actinium and its rare-earth analog lanthanum and emphasizes the need for redetermining the metallic radius of actinium. (auth)

59606 WHITE LINE IN THE L-ABSORPTION SPECTRA OF HEAVY RARE EARTH METALS. Dubey, V. S.; Shrivastava, B. D. (Vikram Univ., Ujjain, India). Phys. Status Solidi (b); 53: No. 1, K51-4(1 Sep 1972).

White lines (maximum of absorption coefficient) are reported at the L_{II} and L_{III} absorption edges of the heavy rare earths (Gd to Lu) in their pure metallic forms. No white line was observed at the L_I edge for Tb to Lu. The positions of the white line peaks with respect to the corresponding main absorption edges are tabulated; the distance from the edge generally falls in the range 4.5 to 6.5 eV. An explanation for the occurrence of the white line is given on the basis of the theoretical density of states. (D.L.C.)

59607 ABSORPTION-LINE SERIES IN Lu I. Camus, P. (CNRS, Orsay, France); Tomkins, F. S. J. Phys. (Paris); 33: No. 2, 197-201(Feb 1972).

The absorption spectrum of lutetium vapor in the ultraviolet region was photographed using the Argonne thirty-foot spectrograph and an inductively heated furnace. Two hundred lines were measured with an accuracy of ± 0.004 Å; approximately 91% of these lines were classified as members of six previously unobserved Rydberg series. Four of these series involve transitions from the two ground-state levels $5d6s^2(^2D_{3/2,5/2})$, and two of them involve the first excited multiplet $6s^26p(^2P^0_{1/2,3/2})$, a level sufficiently populated at the temperature of the experiment. The ionization limit of Lu I was derived from an extrapolation of the $5d6s^2(^2D_{5/2})$ – $nf6s^2(^2F^0_{7/2})$ series measured for n values up to 36, this series being practically free from perturbations. The value determined was 43762.39 ± 0.10 cm^{-1}. (France)

59608 THEORETICAL STUDY OF THE ODD CONFIGURATIONS $4f^{13}5d2s$ AND $4f^{12}6s^26p$ OF Tm I. Camus, P. (CNRS, Orsay, France). J. Phys. (Paris); 33: No. 2, 203-7(Feb 1972). (In French).

Calculations of the energies and Lande factors of the levels of the configurational system $4f^{13}5d6s + 4f^{12}6s^26p$ of Tm I led to the identification of 66 odd levels, the standard deviation of their positions being 79 cm^{-1}. Thirty-seven of the 39 possible $f^{13}ds$ levels were observed. The lowest of these levels (20406 cm^{-1}, 5/2) enabled this configuration to be localized in the Tm I energy-level scheme. The $29f^{12}s^2p$ levels (69 possible levels exist) observed demonstrate that this configuration, which begins at 22468 cm^{-1}, is very similar to the $f^{13}ds$. The eigenvectors are given for the J_1L_2 coupling of $f^{13}ds$ and the J_1j_2 of $f^{12}s^2p$, respectively. (France)

59609 INTERPRETATION OF THE Dy II SPECTRUM. I. STUDY OF ODD LEVELS OF CONFIGURATIONS. Wyart, J. F. (CNRS, Orsay, France). Physica; 61: No. 2, 182-90(15 Sep 1972). (In French).

The extended classification of the Dy II spectrum has led to the discovery of 63 new odd levels which belong to the configurations $4f^96s^2$, $4f^95d6s$, $4f^95d^2$, $4f^{10}6p$. The parametric calculation of the four configurations, taken together, has allowed the interpretation of 113 observed levels with an rms error of 161 K (0.7% of the energy range). Experimental and theoretical results are compared. The values of the radial parameters were fitted by the least-squares method. (auth)

59610 INTERPRETATION OF THE Dy II SPECTRUM. II. STUDY OF $4f^96s6p$ AND $4f^95d6p$ CONFIGURATIONS. Wyart, J. F. (CNRS, Orsay, France). Physica; 61: No. 2, 191-9(15 Sep 1972). (In French).

By means of transitions to $4f^9\ (5d + 6s)^2$, 136 high even levels of DY II were found. The parametric calculation of $4f^96s6p$, taken together, has led to identifying 126 of these levels. The energy levels, their theoretical interpretation, and the fitted values of the radial parameters are given. The relative positions of some configurations are compared in the spark spectra of lanthanides. (auth)

59611 THEORETICAL STUDY OF CONFIGURATIONS $5d6s6p + 6s^27p + 5f6s^2 + 5d^26p$ OF Lu I. Camus, P.; Masmoudi, K. (CNRS, Orsay, France). Physica; 60: No. 2, 513-20(Aug 1972). (In French).

The theoretical study of the odd configurations $5d6s6p + 6s^26p + 5f6s^2 + 5d^26p$ of Lu I according to Racah's methods makes possible an explanation of the energies of 26 levels of LuI with an rms error of 250 cm^{-1}. The calculation of the eigenvectors for 5d6s6p in the intermediate-coupling scheme $[5dj_1, (6s6p)\ [S_2L_2]J_2]$ showed that the intensities of the transitions between the odd levels and those of the fundamental doublet $[5dj_1, 6s^2\ [^1S]0]$ follow the selection rules $\Delta j_1 = 0$ and $\Delta S_2 = 0$. The undefined value of $J\,(3/2$ or $5/2)$ for several levels was fixed by fitting the computed and observed intensities. The effective quantum numbers n^* calculated from the unperturbed positions of the levels belonging to the $6s^27p\,(^2P^0)$ and $5f6s^2\ (^2F^0)$ terms are in good agreement with the observed values for the lowest and highest terms of the two series $6s^2np$ and $6s^2nf$. (auth)

59612 CALCULATION OF PHOTOABSORPTION PROCESSES IN HELIUM. Dalgarno, A.; Doyle, H.; Oppenheimer, M. (Harvard Coll., Observatory, Cambridge, Mass.). Phys. Rev. Lett.; 29: No. 16, 1051-2(16 Oct 1972).

The cross section for photoionization is expressed as an integral over the dipole response function in a form that yields a unified procedure for calculating the background and the resonance contributions. Application is made to absorption by triplet metastable helium. (auth)

59613 PRELIMINARY CLASSIFICATION OF THE ARC SPECTRA OF HOLMIUM. Blaise, Jean; Camus, Pierre; Guelachvili, Guy; Verges, Jean; Wyart, J. F. (CNRS, Orsay, France). Compt. Rend., Ser. B; 274: No. 24, 1302-4(12 Jun 1972). (In French).

The ultraviolet absorption spectra and infrared emission spectra of holmium were studied. The first three levels of the $4f^{11}6s^2\ ^4I$ multiplet ($0_{15/2}$, $5419.7_{13/2}$, and $8544.3_{11/2}$) and the energy of a few levels of the $4f^{11}6s7s$ and $4f^{11}6s6p$ configurations were determined. (France)

59614 MULTIPHOTON IONIZATION AND DISSOCIATION OF MOLECULAR HYDROGEN AT 1.06 μm. Lu Van, M.; Mainfray, G.; Manus, C.; Tugov, I. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Rev. Lett.; 29: No. 17, 1134-7(23 Oct 1972).

An experimental investigation of the multiphoton dissociation and ionization of the hydrogen molecule under the influence of Nd-glass laser radiation at 1.06 μm. The higher electronic states of the potential-energy curves of H_2 are found to play the dominant role. An eleven-photon process is the initial step in the formation of H^+ and a twelve-photon process is the initial step in the formation of H_2^+. (auth)

59615 RADIATIVE DECAY RATES OF METASTABLE ONE-ELECTRON ATOMS. Johnson, W. R. (Univ. of Notre Dame, Ind.). Phys. Rev. Lett.; 29: No. 17, 1123-6(23 Oct 1972).

Decay rates of the $2s_{1/2}$ metastable states of the hydrogen isoelectronic sequence are determined to lowest order in the fine-structure constant α, and to all orders of αZ, for elements with atomic numbers Z ranging from 1 to 92. The M1 decay rate is given in closed analytical form, whereas the E1 rate is determined numerically. The two-photon M1 decay rate is considered and found to be of negligible importance throughout the periodic table. (auth)

59616 RADIATIVE DECAY OF THE 2P STATE OF ATOMIC HYDROGEN: A TEST OF THE EXPONENTIAL DECAY LAW. Wessner, J. M.; Anderson, D. K.; Robiscoe, R. T. (Montana State Univ., Bozeman). Phys. Rev. Lett.; 29: No. 17, 1126-8 (23 Oct 1972).

In Jaynes's semiclassical radiation theory, the decay of an excited atomic state depends on its initial population. For the radiative decay of the 2P level in atomic hydrogen, produced by pulsed excitation from the 2S level, the theory predicts a decay rate $\Gamma = (1 - f)\Gamma_0 + \beta P$, where $\beta = f\Gamma_0$. Here f is the initial 2S population, Γ_0 is the natural 2P decay rate, and P is the 2P population relative to f. For $f = 0.086 \pm 0.016$ and P values in the range 0.15 to 0.64, a measured value $\beta = -(2.8 \pm 2.8) \times 10^6\ s^{-1}$ was obtained. The corresponding value from the semiclassical theory is $\beta = +(53.8 \pm 10.0) \times 10^6\ s^{-1}$. (auth)

59617 THRESHOLD BEHAVIOR OF DOUBLE PHOTO-IONIZATION IN He. Van der Wiel, M. J. (Inst. for Atomic and Molecular Physics, Amsterdam). Phys. Lett.; 41A: No. 4, 389-90(9 Oct 1972).

Roth's threshold law is shown to hold for the case of the double photo-ionization of He. (auth)

59618 VALENCE-BOND AUFBAU PRINCIPLE FOR MOLECULAR EXCITED STATES. Huestis, David L.; Goddard III, William A. (California Inst. of Tech., Pasadena). Chem. Phys. Lett.; 16: No. 1, 157-63(15 Sep 1972).

A modified Aufbau principle for the excited states of molecules is presented. This principle is based on generalized valence-bond orbitals (with spatial projection) rather than the traditional molecular orbitals. The excited orbital is modeled after the series of one-electron heteronuclear diatomic molecules. These ideas are illustrated for the case of the excited $^{1,3}\Sigma^+$ states of H_2. (auth)

59619 PERTURBATION THEORY OF INTERMOLECULAR FORCES IN THE SMALL OVERLAP REGION. PART I. Jeziorski, B.; Piela, L. (Univ., Warsaw). Acta Phys. Pol.; A42: No. 2, 177-84(Aug 1972).

A new perturbational method for the calculation of the interaction between molecules is presented. The method takes into account the proper symmetry requirements for the zero-order wave function, which can be of the Heitler–London type or any better function. Preliminary calculations of the second-order energy correction for the ground and the first excited state of the hydrogen molecule show that this method gives reliable results. (auth)

59620 PERTURBATION THEORY OF INTERMOLECULAR FORCES IN THE SMALL OVERLAP REGION. PART II. Piela, L.; Jeziorski, B. (Univ., Warsaw). Acta Phys. Pol.; A42: No. 2, 185-97(Aug 1972).

Three new perturbation procedures for the calculation of the exchange forces between atoms or molecules are proposed and tested in the case of the ground and the first excited states of the hydrogen molecule. All these procedures have the Rayleigh–Schrödinger framework and are based on the method described in a previous paper (Acta Phys. Pol., A42: 177(Aug. 1972)). For comparison, numerical calculations were also performed by using the Hirschfelder–Silbey (HS), Murrel–Shaw–Musher–Amos (MS–MA) and Hirschfelder–van der Avoird (HAV) procedures. All interaction energies through the second order, with the exception of the HAV result, are similar and coincide very well with the variational energy obtained with the same basis set. Some of the new formalisms give a much better Coulomb energy than the methods used until now. (auth)

59621 INTERFERENCE OF THE $2p_{1/2}$ STATE OF THE HYDROGEN ATOM. Sokolov, Yu. L. (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 2, 461-76(Aug 1972). (In Russian).

Interference of the $2p_{1/2}$ state of the hydrogen atom observed in experiments on the effect of diabatic electric fields on metastable H(2s) atoms is described. With the aid of the atomic interferometer, an arrangement permitting one to observe the atomic-state interference in a space free from any field, it has been possible to determine the Lamb shift between the $2s_{1/2} - 2p_{1/2}$ levels of a hydrogen atom. (auth)

59622 ALTERNATIVE FORMALISM FOR THE METHOD OF INTERMEDIATE HAMILTONIANS. Sack, R. A. (Univ. of Salford, Eng.). Int. J. Quant. Chem.; 6: No. 5, 989-99(Sep 1972).

The methods of intermediate Hamiltonians and of inner projections for the determination of lower bounds of eigenvalues of a Hermitian operator H are analyzed and reformulated as linear matrix problems. Submatrices Γ, which are only defined implicitly through the product $\Gamma\Gamma^\dagger$, are best represented in triangular form. If the subspace complementary to the subspace determining the inner projection can be subdivided with different lower bounds for H, the bounds for the eigenvalues can be further improved. The new formalism is applied to obtain crude lower bounds for the ground state of the helium atom, using only 2 × 2 and 3 × 3 matrices. (auth)

59623 VIBRATIONAL MATRIX ELEMENTS OF THE QUADRUPOLE MOMENT FUNCTIONS OF H_2, N_2, AND CO. **Truhlar, Donald G.** **(Univ. of Minnesota, Minneapolis).** **Int. J. Quant. Chem.; 6: No. 5, 975-88(Sep 1972).**

The quadrupole moment functions (molecular quadrupole moment versus internuclear distance) have been determined by quantum mechanical calculations for H_2 (by Kolos and Wolniewicz), N_2 (by Wahl and Nesbet), and CO (by Nesbet). These functions are used with numerical vibrational wave functions to compute matrix elements that are useful for calculations of scattering cross sections, energy transfer rates and excitation probabilities, and infrared intensities of forbidden bands. (auth)

59624 FLOATING ONE-CENTRE PERTURBATION TREATMENT FOR H_2^+-LIKE MOLECULES. **Ali, M. K.; Meath, W. J. (Univ. of Western Ontario, London). Int. J. Quant. Chem.; 6: No. 5, 949-66(Sep 1972).**

Closed-form one-center partial-wave perturbation results are obtained through second-order in the energy of H_2^+-like molecules with arbitrary nuclear charges. The expansion center for the method is taken at an arbitrary point along the internuclear axis and the zeroth-order wave function is a screened "1s" function centered at the expansion point. Various fixed one-center calculations of other workers for the 1sσ states of H_2^+ and HeH^{2+} and for the 2pσ state of HeH^{2+} are generated as limiting cases of this more general treatment. The floating one-center perturbation results for the 1sσ states of H_2^+ and HeH^{2+} are used as models for discussing the usefulness of allowing the expansion center in the one-center method to be a function of nuclear configuration. (auth)

59625 PERTURBED GENERALIZED EIGENVALUE EQUATION FOR THE HYDROGEN MOLECULAR ION. Woodward, M. R. (Univ. of Nottingham, Eng.). Int. J. Quant. Chem.; 6: No. 5, 911-17(Sep 1972).

The Schroedinger equation for the hydrogen molecular ion is written as a perturbed united atom, which is then treated as a generalized eigenvalue equation. The ground-state energy is calculated through third order for small internuclear distances. (auth)

59626 DETECTION OF THE ORIENTATION OF $^3He^+$ IN AN OPTICALLY PUMPED ^3He DISCHARGE BY ABSORPTION OF THE 10830 A LINE OF ^4He. Vanderlinde, J.; Pinard, M. (Laboratoire de Spectroscopie Hertzienne de l'ENS, Paris). Opt. Commun.; 5: No. 4, 304-6(Jul 1972).

Optical pumping of ^3He atoms in a discharge is known to produce oriented $^3He^+$ ions in the ground state. The ion magnetic resonance ($1\ ^2S_{½}F = 1$) was detected by the absorption of the 10830-Å line of ^4He by metastable $2\ ^3S_1$ neutral ^3He atoms. This implies that $^3He^+$ and metastable $2\ ^3S_1$ state orientations are strongly coupled in the discharge. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 59697, 59733, 59825, 60182, 60377, and 60430.

59627 SINGLE-QUANTUM ANNIHILATION OF POSITRONS BY SCREENED K- AND L-SHELL ELECTRONS. Broda, K. W.; Johnson, W. R. (Univ. of Notre Dame, Ind.). Phys. Rev. A; 6: No. 5, 1693-1702(Nov 1972).

Single-quantum annihilation of positrons in an atomic field is considered. Numerical calculations of the differential and total cross sections and the various polarization correlation functions are presented for the K and L shells of a range of elements from Z = 47 to Z = 92. The positron wave function is described by a partial-wave expansion in angular momentum eigenstates, and the interaction of the positron and bound electron with the radiation field is treated in lowest-order perturbation theory. Numerical programs are constructed for the solution of the radial part of the positron wave function and for the partial-wave phase shifts and normalization factors in an arbitrary non-Coulomb central potential, and for the evaluation of the differential and total cross sections. The effects of screening are included by using the bound-state wave functions and central potentials predicted by the relativistic Hartree–Fock–Slater atomic model. Screening corrections to the Coulomb K-shell total cross sections are found to be sizable for large atomic numbers and low positron energy, and the ratio of L- to K-shell total cross sections is found to be significant for heavy atoms. The angular distributions for this atomic potential exhibit the sharp forward peak predicted in previous work assuming a purely Coulombic potential. (auth)

59628 POSITRON ANNIHILATION IN NITRIC OXIDE AND NITROGEN DIOXIDE. Tao, S. J.; Chuang, S. Y.; Wilkenfeld, J. (New England Inst., Ridgefield, Conn.). Phys. Rev. A; 6: No. 5, 1967-73(Nov 1972).

Positron-annihilation lifetimes in nitrogen dioxide and nitric oxide gases are carefully determined. Nitrogen is used as a dilutant. The free-positron-annihilation rate in units of the effective number of electrons per molecule Z_{eff} for nitrogen dioxide as a mixture of dimers and monomers is determined to be 720 to 1090 and the free-positron-annihilation rate for nitric oxide is $Z_{eff} = 34$. The positronium quenching rate in nitrogen dioxide gas is very high, and the conversion reaction by NO_2 is found to be mainly responsible for the quenching. The quenching rate is determined to be 460D ns^{-1} $amagat^{-1}$, where D is the partial density. The positronium quenching rate in nitric oxide is determined to be only about 0.15D ns^{-1} $amagat^{-1}$, and it changes with the concentration of nitrogen. (auth)

59629 HIGHER-PRECISION DETERMINATION OF THE FINE-STRUCTURE INTERVAL IN THE GROUND STATE OF POSITRONIUM, AND THE FINE-STRUCTURE DENSITY SHIFT IN NITROGEN. Carlson, E. R.; Hughes, V. W.; Lewis, M. L.; Lindgren, I. (Yale Univ., New Haven). Phys. Rev. Lett.; 29: No. 16, 1059-61(16 Oct 1972).

The fine-structure interval $\Delta\nu$ in the ground state of positronium was remeasured with higher precision to obtain $\Delta\nu_{expt} = 203.395 \pm 0.005$ GHz (24 ppM). The current theoretical value is $\Delta\nu_{theor} = 203.4155$ GHz. The different $\Delta\nu_{expt} - \Delta\nu_{theor} = -19 \pm 5$ MHz is about 4 standard deviations of the experimental error, indicating the need for calculations of higher-order radiative contributions. Values are given for both the linear and quadratic coefficients of the fine-structure density shift in N_2. (auth)

59630 POSITRONIUM AND MESONIC ATOMS. **Green, J. H. (St Catharine's Coll., Cambridge, Eng.). pp 251-90 of Radiochemistry. /Maddock, A. G. (ed.). London; Butterworths (1972).**

The properties and the principal features of the chemical reactions of positronium and mesonic atoms are reviewed, and the experimental techniques available for their study are summarized. The section on mesonic atoms includes information on atoms containing particles other than true mesons, such as muons, hyperons, and antiprotons. Emphasis is on positrons and positronium because more extensive literature on these is available. (178 references) (A.G.W.)

59631 SLOW POSITRONS IN RARE GASES. Canter, K. F. (University Coll., London). Contemp. Phys.; 13: No. 5, 457-78(Sep 1972).

The behavior of positrons below the inelastic collision threshold in rare gases can usually be completely accounted for in terms of the annihilation and elastic scattering cross sections for collisions between a positron and a single gas atom. Determining these cross sections has been the subject of many theoretical and experimental investigations. However, the basic premise that the positron interacts with the gas atoms, one at a time, has been recently questioned by the yet-unexplained results of some low-temperature experiments. This article discusses the annihilation and elastic scattering cross sections as they relate to the conventional picture of positrons in rare gases, as well as the possibility of bound states for positrons in the gases at low temperatures. (auth)

Collision Phenomena

Refer also to abstracts 59631, 60329, and 60494.

59632 (UCRL–73777) VACUUM ULTRAVIOLET STUDIES OF RARE GASES AND RARE GAS MIXTURES EXCITED WITH PULSED HIGH ENERGY ELECTRON BEAMS. Krawetz, B.; Rhodes, C. (California Univ., Livermore. Lawrence Livermore Lab.). 9 Jun 1972. 27p. (CONF-720551–1). Dep. NTIS.

From Symposium on high power molecular lasers; Quebec, Canada (15 May 1972).

Preliminary studies are reported on the properties of the rare gas systems argon, krypton, and xenon excited with high-current-density, energetic, pulsed electron beams. The excited media are examined through observation of the vacuum-ultraviolet spontaneous emission originating from the molecular species formed in the excited medium. Experimental data are presented concerning energy transfer processes in Ar/Xe mixtures as well as time resolved spectra of pure Ar, Kr, and Xe in the wavelength region from 1100 to 2500 Å. For the case of 1500 Å band arising from transitions in the krypton dimer, evidence is presented of gain narrowing of the spontaneous emission line at a pressure of five atmospheres. (auth)

59633 ENERGY DISTRIBUTION OF ELECTRONS PRODUCED IN LOW-VELOCITY IONIZING COLLISIONS OF ARGON ATOMS. Berry, H. W. (Syracuse Univ., N. Y.). Phys. Rev. A; 6: No. 5, 1805-8(Nov 1972).

The energy distribution of electrons was measured for ionizing collisions of Ar with Ar in the center-of-mass energy range of 30 to 250 eV. The distributions display several prominent peaks, which can be attributed to the autoionization of highly excited atomic and molecular states. (auth)

59634 MINIMUM-VARIANCE METHOD FOR POTENTIAL SCATTERING. Bardsley, J. N.; Gerjuoy, E.; Sukumar, C. V. (Univ. of Pittsburgh). Phys. Rev. A; 6: No. 5, 1813-18(Nov 1972).

In variational solutions of differential or integral equations the variance integral and variance sum provide measures of the inadequacy of the trial function. For certain potential-scattering problems the variance integral can be used to derive rigorous upper and lower bounds to the phase shift. In more general scattering problems, the study of the variance sum or integral gives a check on the convergence of the standard variational calculations, and an alternative criterion for choosing the best trial function. Results are shown for an attractive exponential potential. (auth)

59635 INNER-SHELL EXCITATIONS IN CLOSE-ENCOUNTER O^+–Ne COLLISIONS AT 50 TO 200 keV. Bingham, Felton W.; Rice, James K. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev. A; 6: No. 5, 1819-22(Nov 1972).

Delayed-coincidence measurements of the average kinetic-energy losses ($\bar{Q}_{mn}$) for O^+–Ne collisions that produce O^{+m} and Ne^{+n} ions are presented. The experiments cover the incident energy range from 50 to 200 keV, values of m and n from 1 to 4, and distances of closest approach (r_0) from 0.15 to 0.016 Å. The $\bar{Q}_{4n}$ and $\bar{Q}_{3n}$ functions are double valued for $r_0 \leq 0.094$ and 0.062 Å, respectively. It is suggested that this phenomenon is the result of K-shell excitation in the oxygen ion. (auth)

59636 CHARGE TRANSFER AT LARGE INTERNUCLEAR DISTANCES: APPLICATION TO ASYMMETRIC ALKALI-ION–ALKALI-ATOM SYSTEMS. Olson, Ronald E. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev. A; 6: No. 5, 1822-30-(Nov 1972).

Numerical coupled-channel two-state calculations have been employed to yield a reduced-total-cross-section curve as a function of reduced velocity for the case where the potential curves lie parallel to one another and there is an exponential coupling between them. This plot may be used to estimate the energy dependence of the charge-transfer inelastic total cross sections for transitions that occur at large internuclear distances because of coupling between two close-lying states. The above plot is specifically applied to several alkali-ion–alkali-atom systems and reasonable agreement is found between theory and experiment. The velocity at which the total cross sections reach their maximum is obtained for the general case and is found to be in fair agreement with experiment. A comparison between the results of Demkov and these calculations is also made. (auth)

59637 IONIZATION CROSS SECTIONS FOR H_2, N_2, AND CO_2 CLUSTERS BY ELECTRON IMPACT. Bottiglioni, Franco; Coutant, Jacques; Fois, Mario (CEN, Fontenay-aux-Rose, France). Phys. Rev. A; 6: No. 5, 1830-43(Nov 1972).

Clusters of condensed matter produced under some particular conditions in supersonic molecular jets can be ionized by electrons. Measured ionization cross sections show a sharp dependence on N, the mean number of molecules per cluster. For small clusters ($\bar{N} < 50$) the cross sections increase as N; for larger clusters as about $\bar{N}^{2/3}$. Furthermore the electron initial energy W_{eM}, for which the cross section is maximum, increases with N. In this paper a model for the computation of the cluster ionization cross sections is presented, which includes the energy losses inside the cluster of both primary and secondary electrons. The escape probability for secondary electrons is given as a function of their initial position and energy. This latter is related to the primary-electron energy. Results of these computations for H_2, CO_2, and N_2 clusters are in good agreement with experimental data. (auth)

59638 EXACT AND SEMI-EMPIRICAL ANALYSIS OF THE GENERALIZED-RANDOM-PHASE-APPROXIMATION OPTICAL POTENTIAL. Csanak, Gyeorgy; Taylor, Howard S. (Univ. of Southern California, Los Angeles). Phys. Rev. A; 6: No. 5, 1843-55(Nov 1972).

A many-body optical potential Σ that has been demonstrated to give excellent electron–helium elastic scattering cross sections is analyzed. It is shown to encompass, yet be more general than, almost all previous model potentials used in electron scattering and Rydberg-state calculations. A partial semiempirical form of this potential is achieved. It is shown how Σ can be computed by methods of variation–perturbation theory. (auth)

59639 SPIN POLARIZATION IN PROTON–XENON CHARGE-EXCHANGE COLLISIONS. Shakeshaft, R.; Macek, J. (Univ. of Nebraska, Lincoln). Phys. Rev. A; 6: No. 5, 1876-85(Nov 1972).

In a recent paper the possibility of producing spin-polarized hydrogen atoms through the charge-exchange reaction $H^+ + Xe \rightarrow H(^2S_{1/2}) + Xe^+ (^2P_{1/2})$ was reported briefly. At proton energies of 15 eV, spin polarization is implied by the preferential population of $Xe^+(^2P_{1/2})$ over $Xe^+(^2P_{3/2})$ and the preliminary two-state calculations presented earlier indicated that a high degree of polarization could be obtained. In this paper a more complete discussion of the earlier work is given. In particular the model upon which the calculations were based is described and the validity of this model is examined. Three-state calculations, which allow for the population of $Xe^+(^2P_{3/2})$, were performed and these results are compared with the earlier two-state results. The polarization was also calculated as a function of scattering angle. It is found that the polarization varies rapidly with angle owing to diffraction effects, and at certain angles almost 100% polarization is achieved. (auth)

59640 BACKSCATTERING CROSS SECTIONS FOR IONIZATION OF SURFACE-ATOM K SHELLS BY ELECTRON IMPACT. Gerlach, Robert L.; DuCharme, A. R. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev. A; 6: No. 5, 1892-1901(Nov 1972).

Backscattering cross sections for the electron-impact K-shell ionization of C, N, O, Na, and Mg adsorbed on a tungsten (100) surface are reported. The ionization event studied is the scattering of K-shell electrons to unfilled states within a few eV of the Fermi level of the W substrate. These data are obtained through a new technique that analyzes the currents in ionization-loss features by comparing them with the currents in the elastic peaks. This technique involves numerical simulation of the ionization features using distribution functions. Measured cross sections in the backscattered region are compared with the Burhop theory over an energy range extending from one to four times the ionization energy. The measured and calculated cross sections decrease with increased atomic number and with primary energy. Although some improvement in shape agreement is noted with increased atomic number, the experimentally derived backscattering cross sections exceed the calculated values for the entire energy range investigated. It is shown that the disagreement noted, even for the higher energy range studied, cannot be attributed to double-scattering processes. The simple theory based on the first Born approximation, although reasonable in total-cross-section determination, is not accurate enough to account for behavior in the backscattered region. (auth)

59641 SEMICLASSICAL THEORY FOR LOW-ENERGY MOLECULAR COLLISIONS. H^+–H_2 VIBRATIONAL EXCITATION. Ritche, Burke (Univ. of Alabama, University). Phys. Rev. A; 6: No. 5, 1902-7(Nov 1972).

A form of semiclassical theory for molecular inelastic or reactive scattering is developed. In such a theory a procedure for separation of the dynamics into two parts, elastic motion and inelastic or reactive motion, is achieved. The isotropic part of the intermolecular potential, V_0, is expanded in a Taylor series about the equilibrium internuclear geometries of the interacting molecules. This separates V_0 into a part that is not dependent on the internal coordinates of the molecules, for which only elastic scattering can occur, and a part that is dependent on the internal coordinates. This latter part, along with the unexpanded anisotropic parts of the intermolecular potential, can act as a "coupler" to produce inelastic or reactive scattering. The constant term in the expansion for V_0 is used as the potential in which the classical trajectory governing the elastic motion is calculated. This determines the "distance of closest approach" and, relative to the range of the couplers, defines an "energy of activation" or effective threshold, if relevant. The time-dependent Schrödinger equation is solved to produce inelastic or reactive probabilities. The theory is applied to H^+–H_2 vibrational excitation in the two- and three-state approximations for energies $15 < E < 1000$ eV. Discrepancies with the measurements of Herrero and Doering probably can be attributed to the omission of the electron-capture channel. The agreement with the $0 \rightarrow 2$ measured cross section above 200 eV is excellent. (auth)

59642 MEASUREMENT OF THE DEPOPULATION OF THE $2^3P_{0\,1\,2}$ LEVELS OF HELIUMLIKE IONS BY ELECTRON COLLISIONS. Engelhardt, W.; Koeppendoerfer, W.; Sommer, J. (Max Planck Institut fuer Plasmaphysik, Munich). Phys. Rev. A; 6: No. 5, 1908-14(Nov 1972).

The collisional depopulation rate of the $2^3P_{0,1,2}$ triplet levels of C V, N VI, O VII, F III, and Ne IX was determined from measured $2\,^3S-2\,^3P$ line intensity ratios. The triplet lines were observed in a hot θ-pinch deuterium plasma seeded with a few percent of the element to be examined. The plasma electron temperature and density were known from laser-light-scattering experiments. The total depopulation rate of the $2\,^3P_{0,1,2}$ levels is mainly due to the $2\,^3S-2\,^3P$ collisional de-excitation rate. The measured rate agrees well with calculations by Blaha based on the Coulomb–Born approximation. With these depopulation rates known, the electron density of the plasma can be determined just by measuring the triplet-line intensity ratios. (auth)

59643 EFFECT OF CORRELATION IN THE TARGET WAVE-FUNCTION ON THE IONIZATION OF HELIUM. Stingl, E. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). J. Phys., B (London); 5: No. 9, 1688-95(Sep 1972).

The effect of the configuration interaction on the cross section for ionization from the helium ground state is studied. The angular distribution of differential cross sections and the cross section for ionization and simultaneous excitation are calculated and compared with measurements of Beaty et al. (JILA Report No. 108. Colorado Univ. (1971)) and calculations of Schulz (Diplomarbeit Universitat Freiburg (1968)) and of Dalgano and McDowell (The Airglow and the Aurorae, p 340-5 (1955)). (auth)

59644 GLORY UNDULATIONS OF SOME ALKALI–MOLECULE SYSTEMS. Dueren, R.; Frick, A.; Schlier, Ch. (Univ., Freiburg i. B.). J. Phys., B (London); 5: No. 9, 1744-55(Sep 1972).

The velocity dependence of the total cross sections for K scattered from CH_4 and Na scattered from CH_4, CH_3OH, CH_2Cl_2, $C(CH_3)_4$, and C_6H_6 was precisely measured, and a phenomenological (nonaveraged) cross section obtained. Since undulation quenching cannot be unambiguously traced back to potential parameters, the measurements were evaluated in terms of a (12–6) potential only, taking semitheoretical van der Waals constants and the positions of the undulation extrema as input. Some computations to assess the effect of an optical potential on integral cross sections are included. An appendix describes the evaluation of Na–Ne scattering, which shows no undulations in this energy range. (auth)

59645 ELECTRON-IMPACT IONIZATION OF IONS TRAPPED IN A HOLLOW ELECTRON BEAM. Hasted, J. B.; Awad, G. L. (London Univ.). J. Phys., B (London); 5: No. 9, 1719-34(Sep 1972).

Introduction of a molecular beam into a hollow cylindrical electron beam generated by a toroidal cathode produces positive ions, which oscillate radially for periods of the order of a second; they are ionized by bombardment with an axial beam of electrons of variable energy; ions of different charge states are extracted axially through an orifice into a quadrupole mass-spectrometer and channeltron detector. In this way cross-section functions for ionization of multiply charged ions are obtained for electron energies between threshold and 500 eV. The cross sections, not being absolute, are normalized against data obtained by crossed-beam techniques. The normalization factors, which are governed by the ion trapping time, are independent of the energy of the axial beam but may depend on the residual gas pressure. They are used with ±30% confidence for multiply charged ion cross-section functions for which only the singly charged ion crossed-beam data are available. These include $Ne^{2+} \rightarrow Ne^{3+}$, $Ne^{3+} \rightarrow Ne^{4+}$, $Ar^{+} \rightarrow Ar^{2+}$, $Ar^{2+} \rightarrow Ar^{3+}$, $Ar^{3+} \rightarrow Ar^{4+}$, for which cross section functions are presented. By the use of a classical scaling factor comparisons are made with other experimental data. A semi-empirical expression is derived for the cross-section functions for $2p^q$ species. It compares well with existing experimental data. (auth)

59646 EXCITATION FUNCTIONS FOR THE FORMATION OF METASTABLE He AND Ar BY ELECTRON IMPACT. Lloyd, C. R.; Weigold, E.; Teubner, P. J. O.; Hood, S. T. (Flinders Univ. of South Australia, Bedford Park, Australia). J. Phys., B (London); 5: No. 9, 1712-18(Sep 1972).

Measurements of the electron-impact excitation functions from threshold to 200 eV, for the formation of metastable helium and argon, using the time-of-flight technique are reported. Both excitation functions have a broad maximum approximately 10 eV above threshold. Near threshold the results are in excellent agreement with earlier measurements, but they are in serious disagreement with the results of Kuprianov, the only previous measurements available over a large energy range. Recent plane- and distorted-wave Born approximation calculations for argon give a poor representation of the data. (auth)

59647 ELECTRON–MOLECULE INTERACTIONS. III. A PSEUDO-POTENTIAL METHOD FOR e^{-}–N_2 SCATTERING. Burke, P. G.; Chandra, N. (Queen's Univ. of Belfast). J. Phys., B (London); 5: No. 9, 1696-1711Sep 1972).

The low-energy scattering of electrons by molecular nitrogen is calculated using a pseudopotential method. Expressions for the cross sections in terms of the calculated S matrix elements are developed and momentum-transfer cross sections are obtained, which are in good agreement with experiment. The theory is then extended to predict rotational excitation cross sections and differential cross sections. It is suggested that this approach may enable electron–molecule collision cross sections involving complex molecules to be calculated. (auth)

59648 CHARACTER OF THE INTERFERENCE OF RESONANCES WITH A CONTINUUM IN THE SPECTRA OF ELECTRONS EJECTED FROM ATOMS BY PROTONS. Lipovetsky, S. S.; Senashenko, V. S. (Moscow State Univ.). J. Phys., B (London); 5: No. 9, L183-6(Sep 1972).

The character of the interference of resonances with a continuum in the spectra of electrons ejected from atoms by protons, which is illustrated by the $(2s2p)^1P^{(-)}$ and $(2s^2)^1S^{(+)}$ autoionizing states, is discussed. (auth)

59649 SCATTERING OF ELECTRONS BY SODIUM ATOMS. Moores, D. L.; Norcross, D. W. (Univ. of Colorado, Boulder). J. Phys., B (London); 5: No. 8, 1482-1505(Aug 1972).

Four-state exchange (3s–3p–4s–3d) close-coupling equations are solved for the scattering of electrons by sodium atoms at incident energies up to 5 eV. The results are presented in such a form that a number of different measurable quantities may be readily extracted from tables and simple formulas. Total and differential (elastic and inelastic) cross sections and the polarization of the resonance doublet radiation are calculated. Results obtained do not differ to any great extent from two-state (3s–3p) calculations of the same quantities. Comparison with available experimental data is made; the total cross section disagrees with the experiment of Brode; and the results obtained for the polarization of the radiation fail to remove the discrepancy between the experiment of Hafner and Kleinpoppen and the two-state calculations by Karule. The polarization agrees well with more recent experimental results, as do the differential elastic scattering and 3s → 3p excitation cross sections. (48 references) (auth)

59650 CROSS SECTIONS CALCULATIONS FOR ELECTRON–OXYGEN SCATTERING USING THE POLARIZED ORBITAL CLOSE COUPLING THEORY. Vo Ky Lan; Feautrier, N.; Le Dourneuf, M.; Van Regemorter, H. (Observatoire de Paris, Meudon, France). J. Phys., B (London); 5: No. 8, 1506-16(Aug 1972).

The formulation given by Feautrier et al. for transitions induced by electron impact among ground-state terms of atoms with one configuration np^q is used with a slight modification by taking into account the orthogonality of the free wave function to the bound np^q orbitals. A system of coupled integrodifferential equations, obtained from a modified close-coupling expansion by including long-range pseudostates, is solved numerically for electrons incident on oxygen in the threshold region. The present results agree very closely with experiment. The generalization of such calculations to other systems with the same type of configuration is straightforward with an automatic code. The multichannel photodetachment cross sections of O^{-} calculated by dipole length and velocity formulas are also reported and discussed. (auth)

59651 COMPLEX COORDINATE SPACE CALCULATIONS FOR RESONANT STATES. Bardsley, J. N.; Junker, B. R. (Univ. of Pittsburgh). J. Phys., B (London); 5: No. 9, L178-80 (Sep 1972).

Complex coordinates are used in a variational calculation of the position and width of the lowest ^1S resonance in e–H scattering. The results of 9.5517 eV and 0.0474 eV, respectively, are in good agreement with experiment and some of the previous calculations. (auth)

59652 FEW-ELECTRON CORRECTIONS OF STATISTICAL EXCHANGE POTENTIAL IN LOW-ENERGY ELECTRON SCATTERING. Schwarz, W. H. Eugen (Univ., Bonn). Chem. Phys. Lett.; 16: No. 1, 89-91(15 Sep 1972).

In order to allow for the relative increase of self-interaction in few-electron systems, a reduction factor is introduced into the statistical free-electron exchange potential. This net-exchange potential was used in the calculation of elastic electron scattering by rare gas atoms in the low-energy region from 0 to 10 eV. Whereas former attempts to treat these phenomena as simple potential scattering have failed, in this work at least a crude qualitative agreement with experimental data is achieved in most cases. (auth)

59653 HARMONIC OSCILLATOR REPRESENTATION FOR ANHARMONIC VIBRATIONAL WAVE FUNCTIONS. Lin, C. S.; Drake, G. W. F. (Univ. of Windsor, Ont.). Chem. Phys. Lett.; 16: No. 1, 35-7(15 Sep 1972).

It is shown that a harmonic oscillator basis set provides a compact analytic representation for the complete set of bound and continuum vibrational states of an anharmonic oscillator in the inner region. Calculations of vibrational excitation cross sections based on a harmonic oscillator model can thus be improved by choosing linear combinations of harmonic eigenfunctions such that the vibrational hamiltonian is diagonal. (auth)

59654 ENERGY DEPENDENCE OF THE TOTAL DIFFERENTIAL CROSS SECTIONS FOR H^++Ar AND H^++Kr. Johnson, R. E.; Carlson, C. E.; Boring, J. W. (Univ. of Virginia, Charlottesville). Chem. Phys. Lett.; 16: No. 1, 119-22(15 Sep 1972).

Total differential cross sections, the sum of the differential cross sections for all processes including charge transfer, were measured for H^+ + Ar and H^+ + Kr. The results are compared to two theoretical models, one employing a single average trajectory and the other based on semiclassical wave analysis. These models give very different results in the rainbow region of the ground-state molecular ion potential when the probability of a transition becomes significant. The second method gives better qualitative agreement with the present data. (auth)

59655 SOLUTION OF DIFFERENTIAL EQUATIONS FOR EXCHANGE MATRIX ELEMENTS IN HEAVY PARTICLE COLLISIONS. Parcell, L. A. (Laval Univ., Quebec City, Quebec). J. Phys., B (London); 5: No. 8, 1478-81(Aug 1972).

The one-electron exchange integrals arising in heavy-particle collisions are solutions to a set of differential equations with respect to time. It is shown that the simple form of this set may be exploited to write immediately an explicit solution in terms of a quadrature and that this solution will allow efficient evaluation of the integrals in steps along the projectile path. (auth)

59656 GENERALIZATIONS OF THE VIRIAL THEOREM IN COLLISION THEORY. McWhirter, J. D. G.; Moiseiwitsch, B. L. (Queen's Univ., Belfast). J. Phys., B (London); 5: No. 8, 1439-55(Aug 1972).

The virial theorem for variational functions in scattering theory is extended to problems involving nonlocal potentials as well as central potentials and to arbitrary values of the scaling parameter. The theory is further generalized to scattering by an atomic system, and the various forms of the virial theorem are applied to the elastic scattering of electrons by hydrogen atoms in which full allowance is made for exchange by employing symmetrized wave functions. (auth)

59657 INFLUENCE OF THE MOLECULAR NATURE OF THE TARGET ON THE PROBABILITY OF PRODUCING K VACANCIES IN VIOLENT ION–MOLECULE COLLISIONS. Fastrup, B.; Crone, A. (Univ. of Aarhus, Denmark). Phys. Rev. Lett.; 29: No. 13, 825-7(25 Sep 1972).

In experiments on violent ion–molecule collisions, it was observed that if the target molecule contains the lower-Z atomic-collision partner, as in e.g., $Ne^+ \rightarrow N_2, NH_3$, the molecular nature of the target has no effect on the probability of producing K vacancies. If, on the contrary, the target molecule contains the higher-Z atomic-collision partner, as in, e.g., $C^+ \rightarrow N_2NH_3$, an appreciable molecular effect is evident. (auth)

59658 X RAYS FROM SUPERHEAVY QUASIATOMS TRANSIENTLY FORMED DURING HEAVY-ION–ATOM COLLISIONS. Mokler, P. H. (Kernforschungsanlage, Juelich, Ger.); Stein, H. J.; Armbruster, P. Phys. Rev. Lett.; 29: No. 13, 827-30 (25 Sep 1972).

X rays produced by 10- to 60-MeV I-ion bombardment of thick Au, Th, and U targets were analyzed with a high-resolution Si(Li) detector. The spectra can be understood in the framework of diabatic molecular orbitals. Radiative transitions in the quasimolecule formed during the collision are observed. These transitions between transient molecular orbitals may be interpreted as M x rays of superheavy quasi atoms with nuclear charges of Z = 132, 143, and 145. (auth)

59659 SOME EXPERIMENTS ON THE ELECTRON PROMOTION MODEL IN ASYMMETRIC HEAVY ION–ATOM COLLISIONS. Tawara, H.; Kistemaker, J. (Inst. for Atomic and Molecular Physics, Amsterdam). Phys. Lett.; 41A: No. 4, 287-9(9 Oct 1972).

Some asymmetric heavy-ion-atom collisions are re-examined in which NeK x rays were observed. The present experiment, using gaseous targets, shows that the NeK x rays observed by these authors do not originate from collisions between the incident Ne^+ ions and various target atoms, but from those between the incident Ne^+ ions and Ne atoms neutralized in the Faraday cage or trapped in the solid Al or C target. This is in better agreement with the electron-promotion model. (auth)

59660 VELOCITY DISTRIBUTION OF THE BOUND ELECTRON IN THE CLASSICAL IMPULSE APPROXIMATION OF BINARY ENCOUNTER THEORY. Tripathi, D. N.; Rai, D. K. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys.; 10: No. 3, 185-6(Mar 1972).

Electron impact ionization cross sections of atoms are calculated using Gryzinski's expression along with various suggested velocity distribution functions for the bound electron. Calculated results of cross sections are compared among each other and with the available experimental data. The importance of the velocity distribution function for the bound electron in the classical encounter theory is discussed. (auth)

59661 MULTIPHOTON DISSOCIATION, PREDISSOCIATION, AND AUTOIONIZATION OF THE HYDROGEN MOLECULE. Mainfray, G.; Manus, C.; Tugov, I. (NRC, Saclay, France). JETP Lett. (USSR) (Engl. Transl.); 16: No. 1, 12-19(5 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 1, 19-23(5 Jul 1972).

Observations of dissociation and ionization of the hydrogen molecule by the second harmonic of a neodymium laser are reported. It is shown that an important role can be played in these processes by multiphoton transitions into highly excited H_2^* Rydberg states. Owing to the strong interaction of the nuclear motion with the electron motion, the excitation of these states is accompanied by a fast nonradiative transition into the continuous spectrum of the electronic wave function (auto-ionization) or the nuclear wave function (predissociation) of the molecule. The experiment enables one to compare the probabilities of direct multiphoton ionization of H_2 and auto-ionization of optically excited Rydberg states. The latter channel is more probable. Multiphoton ionization of H_2 can proceed via predissociation in oscillations during the oscillations, as well as by direct transition of the excited terms into the continuous spectrum of the nuclear wave function, with formation of hydrogen atoms in the ground state H (n = 1) and the excited state H* (n = 2). (auth)

59662 OUTER SHELL EXCITATIONS OF He AND Ne USING PROJECTILES OF C^+, N^+, O^+, F^+, $^{20}Ne^+$, $^{22}Ne^+$, Na^+, AND Mg^+. Andersen, N.; Jensen, K.; Jepsen, J.; (and others) (Univ. of Copenhagen). Z. Phys.; 255: No. 1, 1-13(1972).

He and Ne were bombarded with singly charged ions of elements from carbon to magnesium in the energy range 10 to 75 keV, and photons emitted from the target atoms were detected. The results are discussed in terms of molecular orbital level correlation diagrams in which account is taken of conservation of the total electronic spin. Comparisons are drawn with inner-shell excitations and electronic stopping-power measurements. (auth)

59663 ASYMPTOTIC CROSS SECTION FOR ELECTRON CAPTURE BY FAST PROTONS IN MOLECULAR HYDROGEN AND HELIUM. Potapov, V. S. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 63: No. 2, 431-46(Aug 1972). (In Russian).

Asymptotic expressions for the total and differential charge-exchange cross sections for fast protons in molecular hydrogen and helium are found. The second Born approximation is employed for the amplitudes of each of the processes considered. The formulas for the total capture cross sections are compared with the experimental data. (auth)

59664 LONG-LIVED STATES OF RARE GAS IONS. AN ION KINETIC ENERGY STUDY. Ast, T.; Beynon, J. H.; Cooks, R. G. (Purdue Univ., Lafayette, Ind.). J. Amer. Chem. Soc.; 94: No. 19, 6611-21(20 Sep 1972).

Collision-induced ionization of rare gas ions ($m^+ + N \rightarrow m^{2+} + N + e^-$) was studied by ion kinetic energy spectroscopy. Kinetic-energy-loss spectra, taken using 8-keV reactant ions, provide direct information on the internal energies of the rare gas ions. Typically, reaction occurs from three energy states or groups of states. These are the ground state, a state with energy very close to the second ionization potential, and an intermediate state. The onset of each peak in the energy-loss spectrum corresponds to adiabatic ionization, and this allowed fairly accurate determinations (± 1 eV) of the energies of the reactant ionic states. A state of Ne^+ (energy 27.7 eV above the ground state) was observed, apparently for the first time, to be long-lived ($\geq 10^{-5}$ s). Experiments in which the ion accelerating voltage, collision gas pressure, and ionizing electron energy were varied confirmed the suggested major processes and provided further detail. For example, the highest energy state of the singly charged ions (probably due to high Rydberg levels) reacted both by a collision process and also by a unimolecular mechanism, the latter probably being pseudo-unimolecular and involving collisions with slit surfaces. Fine structure was sometimes observed in the kinetic-energy-loss spectra. In addition to the dominant 10/20 reaction, the 10/21 process was also observed. (auth)

Atomic Theory

Refer also to abstracts 59600, 59619, 59620, 59624, 59910, and 59961.

59665 (NP–19455) HYDROGEN-LIKE RELATIVISTIC CORRECTIONS FOR ELECTRIC AND MAGNETIC HYPERFINE INTEGRALS. Pyykkoe, P.; Pajanne, E. (Jyvaskyla Univ. (Finland). Dept. of Physics). Mar 1972. 28p. Dep. NTIS (U. S. Sales Only).

Expressions are derived for the n-dependent, hydrogen-like relativistic corrections to the magnetic dipole and electric quadrupole radial hyperfine integrals of an arbitrary atomic state. Good agreement has been obtained earlier between these corrections and the relativistic Hartree–Fock results for $s_{1/2}$ states. The agreement remains good for the $p_{1/2}$ states. For the $p_{3/2}$ states in heavier atoms the hydrogenic corrections still reproduce the Hartree–Fock trend. For the higher l values the agreement is poor. Numerical tables are given for $1 \lesssim Z \lesssim 100$ for the $s_{1/2}$, $p_{1/2}$, and $p_{3/2}$ magnetic dipole cases and the $p_{3/2}$ quadrupole case. (auth) (Finland)

59666 HYLLERAAS-TYPE WAVE FUNCTIONS FOR SOME EXCITED THREE-ELECTRON S STATES. Larsson, Sven (Univ. of Uppsala). Phys. Rev. A; 6: No. 5, 1786-90(Nov 1972).

The usefulness of Hylleraas-type wave functions for variational calculation of three-electron excited S states is investigated. The four lowest $(1s^2ns)$ ^2S wave functions for lithium are obtained in the same 57-term basis. The calculated energies are –7.47782, –7.35392, –7.31837, and –7.30339 au compared to the corrected experimental results –7.47807, –7.35410, –7.31853, and –7.30355 au. The largest part (0.00015 au) of the discrepancies is due to approximations in the core function. For the lowest ^4S state for lithium a 44-term basis was used with the resulting energy –5.21240. The wave function was analyzed in terms of natural orbitals and found to exhibit strong 2s3s–2p3p "near degeneracy." The density for the Li state is significantly correlation-contracted in the 3s region. (auth)

59667 BRILLOUIN'S THEOREM FOR INTERSHELL CORRELATIONS IN THE ATOMIC HARTREE–FOCK METHOD. Labarthe, J. J. (Laboratoire Aime Cotton, Orsay, France). J. Phys., B (London); 5: No. L181-2(Sep 1972).

Brillouin's theorem is shown to be valid for excitations of the kind $1s^22s \rightarrow 1s2s^2$. Consequently, the simple Hartree–Fock wave function is accurate up to the second order of perturbation for the field part of atomic isotope shifts in usual cases. (auth)

59668 POLARIZED CORE APPROXIMATION FOR ATOMIC STRUCTURE CALCULATIONS. Seaton, M. J. (University Coll., London); Wilson, P. M. H. J. Phys., B (London); 5: No. 9, L175-7(Sep 1972).

The wave functions for electron collisions with an N-electron ion may be expanded in terms of functions for the ion core multiplied by orbital functions for the colliding electron. In the expansion both unperturbed ion states and states of the ion in an electric field may be included, calculated using first-order perturbation theory (the so-called pseudostates). The radial functions for the colliding electron satisfy a system of coupled integrodifferential equations. These equations may be solved at energies that give bound states for the (N + 1)-electron system. This method was used to calculate energy levels for He with inclusion of the unperturbed and the polarized He^+ ground state. Results for the levels n^1S, ^3S, ^1P, ^3P, ^1D, and ^3D, up to n = 3, are much superior to those obtained in the "frozen-core" approximation. (auth)

59669 COMMUTATOR TECHNIQUES IN PERTURBATION THEORY. Killingbeck, J. (Univ. of Hull, Eng.). J. Phys., B (London); 5: No. 9, 1655-61(Sep 1972).

A simple commutator technique is used to find the first-order perturbation correction to the expectation values of certain coordinate operators. The method is applied to three calculations involving two-electron ions, and the results are compared with those obtained by variational methods, in particular the correlation splitting approach. Some useful hydrogenic integrals are tabulated. (auth)

59670 EXTENDED HARTREE–FOCK THEORY FOR EXCITED STATES. Morokuma, K.; Iwata, S. (Univ. of Rochester, N. Y.). Chem. Phys. Lett.; 16: No. 1, 192-7(15 Sep 1972).

An extended Hartree–Fock method for excited states is proposed. Starting from the ground-state Hartree–Fock molecular orbitals and allowing mixing within occupied and vacant subspaces, respectively, the energy of a single-configuration excited state is minimized. This wave function satisfies the orthogonality and Brillouin theorem not only with the ground state but also with other excited states. One of the major advantages of the method is the common set of MO's for the ground and excited states. By making an additional assumption this method reduces to Huzinaga's scheme. A few sample calculations are presented. (auth)

59671 ENERGY LEVELS AND ELECTROMAGNETIC PROPERTIES OF HYDROGEN-LIKE ATOMS. Faustov, R. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Fiz. Elem. Chastits At. Yadra; 3: No. 1, 238-68(1972). (In Russian).

The present status of the theory of the simplest two-particle systems, the hydrogen-like atoms, is reviewed. As a foundation of such a theory the three-dimensional quasi-potential method of Logunov and Tavkhelidze is used in the new relativistically invariant formulation proposed by the author. Most attention is paid to the energy-level corrections for nuclear-structure and motion effects, the positronium energy levels, and the relativistic corrections to the atomic magnetic moment. The theory is compared with the most recent experimental data. (58 references) (auth)

59672 STATISTICAL THEORY OF ATOM AND ION POLARIZABILITY. Vinogradov, A. V.; Pustovalov, V. V.; Shevel'ko, V. P. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 2, 477-81(Aug 1972). (In Russian).

It is shown that the potential and the distribution of the electron density within an atom or ion located in a homogeneous electric field satisfy the equation derived by linearizing the Thomas–Fermi equation. A universal dependence of the polarizability of atoms or ions on their radius is set up by numerical solution of the equation. The results of the calculations are in good agreement with available experimental data on the polarizability of atoms and ions with filled shells. (auth)

59673 BEHAVIOUR OF HARTREE–FOCK AND HARTREE–FOCK–SLATER (Xα) ATOMIC FORM FACTORS AND ELECTRON MOMENTUM DISTRIBUTIONS FOR TWO-, THREE-, AND FOUR-ELECTRON IONS. Singh, S. R. (Queen's Univ., Ont.); Smith, V. H. Jr. Z. Phys.; 255: No. 1, 83-92(1972).

The atomic form factor and the radial electron density in momentum space, from the solutions of the α-parameterized Hartree–Fock–Slater (Xα) equations, are studied within the framework of Z^{-1} expansion theory for the two-, three- and four-electron ions in their ground-state configurations $(1s^2)$, $(1s1s'2s)$, and $(1s^22s^2)$ and compared with the corresponding Hartree–Fock quantities. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

Refer also to abstract 60005.

59674 CONVECTION-DRIVEN HYDROMAGNETIC DYNAMO. Childress, S. (New York Univ., N. Y.); Soward, A. M. Phys. Rev. Lett.; 29: No. 13, 837-9(25 Sep 1972).

A hydromagnetic dynamo utilizing Bénard convection between rotating parallel planes is described. The model is based upon an asymptotic expansion in two spatial scales valid for large Taylor number. (auth)

59675 MHD FLOW OF A VISCOUS FLUID PAST AN INFINITE PLATE WITH TIME-DEPENDENT SUCTION. PART I. Soundalgekar, V. M. Publ. l'Inst. Math.; 10: 169-84(1970).

The problem deals with oscillating flow of vanishing magnetic Reynolds number and a uniform transverse magnetic field. Neglected is the electric field which corresponds to a uniform potential on the plate and at infinity in the frame of the plate. The laminar boundary-layer equations reduce to a single linear partial differential equation in tangential velocity. Fourier expansion leads to a system of ordinary differential equations. A regular perturbation in the amplitude of the suction velocity leads to a solution in terms of standard functions. A second-order effect on the wall shear stress is peculiar to the MHD problem. MHD enhances the tendency toward separation for suction 90° out of phase with the free stream, while it lessens it for in-phase or directly out-of-phase variation. The energy equation neglecting Joule heating, but including viscous dissipation, is solved for a thermally insulated wall. Graphs and tables of results are given. A knowledge of the MHD laminar boundary-layer equation is assumed. (App. Mech. Rev.)

59676 UNSTEADY MAGNETOHYDRODYNAMIC FLOW OVER YAWED INFINITE CYLINDER. Pop, Ioan. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 51: No. 5, 367-70(Nov 1971).

The development of unsteady flow of an electrically conducting fluid, impulsively brought into motion with a constant velocity from rest in the vicinity of the rear-stagnation line of a yawed infinite cylinder, is considered. (M.H.R.)

59677 ON A RESOLUTION OF THE EQUATIONS GOVERNING THE SECOND-ORDER CORRELATION FUNCTIONS FOR AN ISOTROPIC HYDROMAGNETIC TURBULENCE. Codreanu, S. (Univ., Cluj). Acta Phys. Pol.; A42: No. 2, 123-8(Aug 1972).

The possibility of solving the system of Chandrasekhar's equations by using the power series expansions for the correlation functions is discussed. (auth)

59678 DYNAMICS AND ELECTRODYNAMICS OF FARADAY RING CURRENTS IN A MAGNETOPLASMADYNAMIC LOW-PRESSURE CIRCULAR CHANNEL WITH RADIAL MAGNETIC FIELD. Rothhardt, L. (Zentralinstitut fuer Elektronenphysik, Jena, Ger.). Beitr. Plasmaphys.; 12: No. 1, 27-38(1972). (In German).

A magnetoplasmadynamic circular channel with radial magnetic field was coupled to a shock tube of inductive hydrodynamic characteristics. It was thus operated with plasma of low pressure and supersonic velocities. It was possible to induce narrowly localized Faraday ring currents of around 1 kA with magnetic fields up to 2.4 kG and plasma velocities around 10^6 cm/s (hydrogen) and 3×10^5 cm/sec (argon), respectively. Neither a significant Hall effect nor a significant rise in electron temperature was observed in the ring current. (tr-auth)

59679 CALCULATION OF α EFFECTS WITH CONSIDERATION OF GYRATIONAL MOTION OF ELECTRONS AND IONS. Helmis, G. (Zentralinstitut Physik, Berlin). Beitr. Plasmaphys.; 12: No. 1, 39-44(1972). (In German).

The alpha effect is calculated for an electrically conductive medium. The velocity field of the medium is homogeneous, isotropic, nonmirror symmetrical, and stochastic. Its electrical properties are determined not only by an electron Hall effect but also by an ion Hall effect. In comparison with the case in which only gyrational motions of electrons play a role, the gyrational motion of ions may lead to an enhancement as well as to a reduction of the alpha effect. At very high electrical conductivities, the Hall effect has no influence. (tr-auth)

PHYSICS (HIGH-ENERGY)

59680 HIGH ENERGY PHYSICS: ELEMENTARY PARTICLES. Omnes, Roland. pp 414-43 of Physics. Paris; Centre d'Etude et de Promotion de la Lecture (1971). (In French).

The properties of the principal elementary particles are reviewed: electrons, photons, nucleons, neutrinos, antiparticles, and strange particles; the ways in which these particles are detected and studied are presented. (auth)

Particle Interactions and Properties (Experimental)

Refer also to abstract 58895.

59681 (COO-3023-16) HIGH ENERGY PHYSICS AT TUFTS UNIVERSITY. Progress Report, September 1972. (Tufts Univ., Medford, Mass.). 1972. Contract AT(11-1)-3023. 19p. Dep. NTIS.

A summary of research on high energy physics is presented. A list of publications is included. (J.F.P.)

Electromagnetic

Refer also to abstracts 59715, 59779, 59790, and 60103.

59682 (DESY-72/34) PHOTON-HADRON INTERACTIONS (EXPERIMENTAL). Meyer, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1972. 47p. (CONF-720419-3). Dep. NTIS (U. S. Sales Only).

From fourth international conference on high energy collisions; Oxford, England (5 Apr 1972).

A review is given of the evidence for the hadronic nature of the photon. Vector and pseudoscalar meson production, total cross section measurements, and inclusive photoproduction data are discussed. (J.F.P.)

59683 (LAL-RI-72-3) ANNIHILATION REACTION $e^+e^- \rightarrow 2\gamma$ AT 990 MeV IN THE ORSAY STORAGE RING. Szklarz, G. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). May 1972. 51p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The $e^+e^- \rightarrow 2\gamma$ cross section was measured in the 90° region, large angle Bhabha scattering being used for the normalization. The cross section obtained: $\sigma = (0.509 + -0.060) 10^{-31}$ cm^2 is in excellent agreement with that predicted by quantum electrodynamics. The cutting parameter characterizing the validity of the quantum electrodynamics was deduced: $\Lambda = 1.4$ GeV. The behavior of the photon showers in the apparatus led to the exploration of a narrow band around 90° and in consequence, a restricted number of events. (France)

59684 SEARCH FOR TACHYON MONOPOLES. Bartlett, D. F.; Lahana, M. D. (Univ. of Colorado, Boulder). Phys. Rev., D; 6: No. 7, 1817-23(1 Oct 1972).

A search was made for a magnetically charged particle that travels faster than light. These particles are detected by the Cherenkov radiation they emit while moving in a magnetic field. It is found that the cross sections for photoproduction of these particles by 1-MeV γ rays in lead and water are less than 0.6×10^{-36} and 2×10^{-36} cm^2, respectively. These results are subject to some assumptions about the hypothetical particles. (auth)

59685 INCLUSIVE PHOTON YIELDS FROM HIGH-ENERGY BREMSSTRAHLUNG. Worster, B. W.; Caldwell, D. O.; Elings, V. B.; (and others) (Univ. of California, Santa Barbara). Lett. Nuovo Cim.; 5 No. 3, 261-5(16 Sep 1972).

Lead-glass shower counters were used to measure the energy spectra of photons produced near 8° from a hydrogen target by 18.0- and 20.5-GeV bremsstrahlung. The inclusive photon yield angular dependence, the spectrum angular and energy dependence, and the invariant cross sections are discussed. (J.F.P.)

59686 SEARCH FOR MASSIVE INTERACTING PARTICLES NEAR THE CORES OF EXTENSIVE AIR SHOWERS OF ENERGIES OF ABOUT 2×10^{14}–10^{16} eV. Tonwar, S. C.; Naranan, S.; Sreekantan, B. V. (Tata Inst. of Fundamental Research, Bombay). J. Phys., A (London); 5: No. 4, 569-83(Apr 1972).

An experiment carried out at mountain altitude to study the time structure of hadrons in extensive air showers revealed the existence of a special class of delayed high energy interacting particles at distances less than 20 m from the axes of showers of energy greater than 2×10^{14} eV. These particles having energies more than 20 GeV and delays more than 20 ns relative to the air shower front constitute about 0.5% of the hadrons of similar energy. Detailed calculations predict the frequency of events with such delay-energy characteristics to be less than 10^{-4} if they are due to known hadrons like nucleons and pions. The high energy large delay events however can be understood if there exist particles much heavier than nucleons (mass > 10 GeV/c^2) which are produced in ultrahigh energy interactions. Under certain assumptions the flux of such massive interacting particles was deduced from the experimental data as approximately 10^{-9} cm^{-2} s^{-1} sr^{-1}. It is shown that such a flux is not inconsistent with the upper limits given by earlier experiments. The present experiment does not give any information on the charge of these particles. Further experiments incorporating visual detectors and timing systems are needed to substantiate the interpretation of the events in terms of heavy mass particles. (auth)

59687 DETERMINATION OF THE RATIO OF THE PROTON AND DEUTERON NUCLEAR MAGNETIC MOMENTS. Kaminker, D. M.; Neronov, Yu. I.; Mukhamadiev, Kh.; Pautov, A. I. (Inst. of Nuclear Physics, Leningrad). Zh. Eksp. Teor. Fiz.; 63: No. 2, 393-400(Aug 1972). (In Russian).

The ratios of the proton and deuteron resonance frequencies in H_2O-D_2O $(CH_3)_2CO-(CD_3)_2CO$ mixtures and for partially deuterized acetones are determined. The data obtained are compared with those available in the literature. For determination of the magnetic moment ratios allowance must be made for corrections for the differences in the oscillation amplitudes as well as for quadrupole interactions, both types of corrections having opposite signs. The analysis carried out shows that the most probable value of the proton and deuteron gyromagnetic ratio should be close to the resonance frequency ratio obtained for the HOD molecule. For this molecule both corrections apparently compensate each other. (auth)

59688 CHARGED AND NEUTRAL DOUBLE PION PHOTOPRODUCTION CROSS-SECTIONS IN THE γ-RAY ENERGY RANGE (600 TO 900) MeV. Beneventano, M.; d'Angelo, S.; de Notaristefani, F.; (and others) (Univ., Rome). Lett. Nuovo Cim.; 5: No. 1, 93-6(2 Sep 1972).

The reactions $\gamma + p \rightarrow p +$ at least one charged particle and $\gamma + p \rightarrow p +$ anything were investigated at the Frascati electrosynchrotron for γ-ray energies from 600 to 900 MeV, at fixed proton laboratory emission angle $\theta_p = 32°$ and for five proton laboratory momenta p = 410, 440, 475, 510, and 550 MeV/c. Five yields Y(E) corresponding to the proton momenta were measured and are presented along with their best polynomial fits. The corresponding differential cross sections are also presented. (L.B.S.)

59689 MEASUREMENT OF THE MAGNETIC MOMENT OF THE Λ^0 HYPERON. Barkov, L. M.; Gurevich, I. I.; Makar'ina, L. A.; (and others). JETP Lett. (USSR) (Engl. Transl.); 16: No. 3, 104-5(5 Aug 1972).

Translated from Zh. Eksp. Theor. Fiz., Pis'ma Red.; 16: No. 3, 151-3(5 Aug 1972).

From 57 events of the $\Lambda \rightarrow p + \pi^-$ decay, satisfying all the previous selection criteria, the value of the Λ^0 magnetic moment was determined by the maximum-likelihood method. (J.F.P.)

Weak

Refer also to abstract 59715.

59690 (FRNC-TH-224) MEASUREMENT OF THE RATIO $|\eta_{00}|e^{i\varphi}$ OF THE DECAY AMPLITUDES OF K_L^0 AND K_S^0 IN THE $2\pi^0$ MODE, THE K_L^0 INTO 2γ BRANCHING RATIO, AND THE UPPER LIMIT OF THE K_S^0 INTO 2γ BRANCHING RATIO. Wolff, B. (Paris Univ., Orsay (France)). [nd]. 100p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The way in which $2\pi^0$ and 2γ events are selected is described. The $2\pi^0$ experiment is analyzed. The violation of PC in K disintegration observed in recent determinations of $|\eta_{00}|$ and φ_{00} is discussed. Previous experimental results are discussed together with theoretical questions linked to K^0 into 2γ disintegrations. The 2γ experiment is analyzed. (France)

59691 MEASUREMENT OF THE K_L^0 MEAN LIFE. Vosburgh, Kirby G. (Rutgers—The State Univ., New Brunswick, N. J.);

Devlin, Thomas J.; Esterling, Robert J.; (and others). Phys. Rev., D; 6: No. 7, 1834-51(1 Oct 1972).

A new measurement of the mean life of the K_L^0 meson was made in a scintillation-counter experiment by observing the exponential decrease in K_L^0 flux as a function of distance in a collimated neutral beam. $\tau = (5.154 \pm 0.044) \times 10^{-8}$ sec was found. This result strengthens the conclusion that the predictions of a pure $\Delta I = 1/2$ rule are not correct for $K_{\pi 3}$ decay. (auth)

Strong (Baryon-induced)

Refer also to abstracts 59630, 59895, and 59900.

59692 (CEA-N-1547) ELASTIC NUCLEON-NUCLEON SCATTERING DATA 270 TO 3000 MeV. Bystricky, Jiri; Lehar, Franz; Janout, Zdenek (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1972. 384p. Dep. NTIS (U. S. Sales Only).

A compilation of p-p, n-p and n-n elastic scattering data and total cross sections for elastic and inelastic nucleon-nucleon processes measured in the 270 to 3000 MeV energy range is presented. The data are given in detailed tables with comments on each measurement. Summary tables, nucleon-nucleon kinematics formulas, transformation tables for kinematics, a detailed list of references and an author index are also presented. (France)

59693 (LA-DC-72-1070) RESEARCH ON FEW PARTICLE SYSTEMS AT LAMPF. Simmons, James E. (Los Alamos Scientific Lab., N. Mex.). 1972. Contract W-7405-eng-36. 20p. (CONF-720819-16). Dep. NTIS.

From International conference on few particle problems in nuclear interactions; Los Angeles, CA. (28 Aug 1972).

A summary is given concerning the scope of proposals for future research on few particle systems at LAMPF, together with discussion of selected subjects. The relevance of deuteron polarization measurements is mentioned, and a possible discrepancy is noted concerning knowledge of the forward p-p amplitudes at medium energy. (auth)

59694 Σ^-p AND Σ^-d TOTAL CROSS SECTIONS AT 19 GeV. Badier, J. (Ecole Polytechnique, Paris); Bland, R.; Romana, A.; (and others). Phys. Lett.; 41B: No. 3, 387-92(2 Oct 1972).

The total cross sections of 18.7-GeV Σ^- hyperons on protons and deuterons were measured to be 34.0 ± 1.1 mb and 61.3 + 1.4 mb, respectively. The derived Σ^--neutron cross section is 30.0 ± 1.2 mb. (auth)

59695 MEASUREMENT OF THE SPIN CORRELATION PARAMETERS A_{yy} AND A_{xx} OF PROTON-PROTON SCATTERING AT 47.5 MeV. Hasegawa, Takeo (Kyoto Univ.); Horikawa, Naoaki; Nakanishi, Tsutomu; (and others). J. Phys. Soc. Jap.; 33: No. 4, 871-80(Oct 1972).

The measurement of the spin correlation parameters of proton-proton scattering at 47.5 MeV was done by using polarized beam and polarized target. A proton beam which had 50% polarization was provided by p-Ca scattering. The polarized target was a LMN crystal which was maintained 35% polarization by dynamic method during the experiment. The spin correlation parameters A_{yy} and A_{xx} at 90°C_{CM} were measured simultaneously. A_{yy}, A_{xx} and A_{yy}/A_{xx} at 47.5 MeV were −0.287 ± 0.039, −0.713 ± 0.032 and 0.402 ± 0.057, respectively. (auth)

59696 LIFETIME OF HEAVY SPALLATION HYPERFRAGMENTS. Husain, A.; Kasim, M. M.; Basak, A. K.; (and others) (Univ. of Rajshahi, India). Nucleus (Karachi); 8: No. 5, 55-62 (1971).

An estimation of the lifetime of heavy spallation hyperfragments is made from the forward to backward ratio of recoils (from hyperfragment centers) with respect to hyperfragment direction at the decay point. The mean lifetime is found to be $\tau = (2.43^{+0.87}_{-0.40}) \times 10^{-12}$ sec. This result is in agreement with that found experimentally by Bhalla, et al. $\tau = (1.5^{+0.9}_{-0.4}) \times 10^{-12}$ sec but about 10^{-2} times smaller than that predicted by Dalitz. (auth)

59697 STRONG-INTERACTION EFFECTS IN ANTIPROTONIC ATOMS. Barnes, P. D. (Carnegie-Mellon Univ., Pittsburgh); Dytman, S.; Eisenstein, R. A.; (and others). Phys. Rev. Lett.; 29: No. 17, 1132-4(23 Oct 1972).

The energies and widths of the x-ray lines from the 4f → 3d transition in antiprotonic atoms of ^{14}N and ^{16}O were measured. The results are discussed in terms of a phenomenological optical potential. Also the x-ray line from the 3d → 4p transition in the antiprotonic ^{4}He atom was observed. (auth)

59698 CHARGED PARTICLE DISTRIBUTION IN INELASTIC PROTON-NEUTRON INTERACTIONS AT THE MOMENTUM 19.2 GeV/c. Boos, E. G.; Zhautykov, B. O.; Lukin, E. S.; Mosienko, A. M.; Tursunov, R. A. (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 16: No. 2, 335-8(Aug 1972). (In Russian).

The first experimental results obtained from the analysis of proton-neutron interactions at the momentum 19.2 GeV/c in the deuterium bubble chamber are presented. The distribution of 3746 inelastic collisions over the number of secondary charged particles is obtained. The results are compared with the data on proton-nucleon interactions at the energies almost similar. (auth)

59699 STUDY OF THE LIGHT FRAGMENTS PRODUCED IN THE REACTION OF 19.8-GeV/c PROTONS WITH ALUMINUM. Bolta, J. M.; Melia, J.; Villar, E. (Instituto de Fisica Corpuscular, Valencia). An. Fis.; 67: No. 7-8, 301-12(1971). (In Spanish).

The most important technical aspects of a new experimental method projected for the study of the p-nucleus interactions are presented. The energy distributions of the protons, deuterons, tritium, helium-3 and alpha particles produced in the p-Al interactions at 19.8 GeV/c are shown. The results are compared with the predictions of the evaporation model. (auth)

Strong (Meson-induced)

Refer also to abstract 59849.

59700 (DESY-72/37) REACTION $\pi^+p \to \omega\Delta^{++}$ (1236) AT 11.7 GeV/c. Evans, D.; Maddock, R. O.; Pinter, G. F.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). Jul 1972. 27p. Dep. NTIS (U. S. Sales Only).

For the reaction $\pi^+p \to \omega\Delta^{++}$ data on the total cross section ($\sigma = 61 \pm 12$ μb), differential cross sections, spin density matrix elements, and statistical tensor elements are given. Natural and unnatural parity exchange contributions to the total cross section are observed. It is noted that the value of ρ_{00} is not zero and in the helicity frame exhibits a dip at $t \approx -0.25$ (GeV/c)^2. A qualitative theoretical discussion of the results is presented. (auth)

59701 (SLAC-PUB-1045) CROSS-OVER EFFECT IN INELASTIC REACTIONS. Leith, D. W. G. S. (Stanford Linear Accelerator Center, Calif.). Apr 1972. 22p. (CONF-720333-2). Dep. NTIS.

From seventh rencontre de moriond conference; Meribel-les-Allues, France (5 Mar 1972).

A crossover in the differential cross sections for the processes $K^0 + p \to Q^0 + p$ and $\overline{K}^0 + p \to \overline{Q}^0 + p$ in a hydrogen bubble chamber is studied. The cross section for Q production is also found. (J.F.P.)

59702 (SLAC-PUB-1046) K_L^0p INTERACTIONS AND EXCHANGE DEGENERACY. Leith, D. W. G. S. (Stanford Linear Accelerator Center, Calif.). Apr 1972. 30p. (CONF-720333-3). Dep. NTIS.

From seventh rencontre de moriond conference; Meribel-les-Allues; France (5 Mar 1972).

Exchange degeneracy is tested in $\overline{K}_2^0 + p \to K^- + \Delta^{++}$ interaction cross sections and slopes of differential cross sections, $\overline{K}_2^0 + p \to \Lambda + \pi^+$ interaction differential cross sections and polarization, and $\overline{K}_2^0 + p \to \Sigma^0 + \pi^+$ interaction differential cross sections below 10 GeV/c in hydrogen bubble chamber. (J.F.P.)

59703 (UH-511-132-72) PRODUCTION MECHANISMS IN MULTIPION PRODUCTION IN π^-p COLLISIONS AT 3.9 AND 11.9 GeV/c. Johnson, A. D.; Peters, M. W.; Stenger, V. J.; Wohlmut, P. G ; Yee, A. (Hawaii Univ., Honolulu). Aug 1972. Contract AT(04-3)-511. 16p. (CONF-720923-4). Dep. NTIS.

From 16th international conference on high energy physics; Chicago, IL. (6 Sep 1972).

Data were fit for the following reactions: $\pi^-p \to \pi^-\pi^-\pi^+p$, $\pi^-p \to \pi^-\pi^-\pi^+\pi^0p$, $\pi^-p \to \pi^-\pi^-\pi^+\pi^+n$, $\pi^-p \to \pi^-\pi^-\pi^-\pi^+\pi^+p$, $\pi^-p \to \pi^-\pi^-\pi^-\pi^+\pi^+\pi^0p$, and $\pi^-p \to \pi^-\pi^-\pi^-\pi^+\pi^+\pi^+n$ at 3.9 and 11.9 GeV/c to a quasi-two-body model in which the main features of pion exchange and diffraction dissociation are simply represented. The basic invariant mass and momentum transfer distributions are described with no more than 7 adjustable parameters used for a given reaction and energy. Samples of these fits are given. The method is used to determine cross sections for the basic mechanisms and resonances present at the two energies which contribute to the multipion systems observed. Results are presented. The energy dependence expected for pion exchange and diffraction dissociation is observed to be consistent with the results as illustrated. Various factorization predictions suggested were tested and found consistent. (auth)

59704 DETERMINATION OF THE FRACTION OF π^-p-INTERACTION IN A HEAVY-LIQUID BUBBLE CHAMBER WITH A MAGNETIC FIELD. Vorob'ev, I. I.; Novikov, L. S.; Shishov, N. N. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 58-60(1972).

Translated from Prib. Tekh. Eksp.; No., 15: No. 1, 58-60(1972).

A study was made of the fraction of events in free hydrogen involving 0-2-4-prong stars which develops as a result of the interaction of π-mesons with the nuclei of a propane—xenon mixture. In the experiment a 120-liter bubble chamber was used which was irradiated with π-mesons having a momentum of 2.94 GeV/c on the proton synchrotron of the Institute of Theoretical and Experimental Physics. The chamber was placed in a magnetic field of 18 kG. The fraction of events in free hydrogen involving zero-prong stars turned out to equal (42.6 ± 6.0)%; for two-prong stars it was (53.4 ± 4.1)%, and for 4-prong stars it was (41.6 ± 6.0)%. (auth)

59705 ANALYSIS OF THE Q IN $K^-d \rightarrow K^-\pi^-\pi^+d$ AND $K^-d \rightarrow K^-\pi^-\pi^+np_s$ AT 7.3 GeV/c. Anderson, K. J.; Franklin, A. D.; Godden, G. D.; (and others) (Univ. of Colorado, Boulder). Phys. Rev., D; 6: No. 7, 1823-33(1 Oct 1972).

Results from the study of reactions (1) $K^-d \rightarrow K^-\pi^-\pi^+d$ and (2) $K^-d \rightarrow K^-\pi^-\pi^+np_s$ at 7.3 GeV/c are presented. The interactions are dominated by the production of K*(890), ρ(765), Q(1200—1450), and D*(2200) in (1) and Δ^-(1236) in (2). Observation of ρ(765) and its possible source as a misidentified K*(890) is discussed. Evidence is observed of splitting of the Q into two resonances with masses and widths (in MeV) $M_1 = 1228 \pm 21$, $\Gamma_1 = 111 \pm 33$, $M_2 = 1414 \pm 15$, and $\Gamma_2 = 89 \pm 24$. L(1775) is observed in (1). An off-shell one-pion-exchange-model calculation is compared to (2). Cross sections and branching ratios of the Q resonances are estimated on the basis of the model. (auth)

59706 STUDY OF THE REACTION $K^+n \rightarrow K^+N^{*0}$ AT 12 GeV/c. Lissauer, D.; Firestone, A.; Ginestet, J.; Goldhaber, G.; Trilling, G. H. (Univ. of California, Berkeley). Phys. Rev., D; No. 7, 1852-62(1 Oct 1972).

The reaction $K^+n \rightarrow K^+N^{*0} \rightarrow K^+\pi^-p$ at 12 GeV/c was studied using data obtained in an exposure of the deuterium-filled SLAC 82-in. bubble chamber in an rf-separated K^+ beam. The M(pπ^-) spectrum exhibits a very large enhancement below 1.8 GeV which is identified as primarily a diffractive effect. A partial-wave analysis of this enhancement shows that the data can be interpreted in terms of $P_{1/2}$, $D_{3/2}$, and $F_{5/2}$ contributions. The $P_{1/2}$ contribution which dominates at very low momentum transfers appears to peak around 1.25 GeV. If this state is associated with the Roper resonance, a mechanism which produces a downward mass shift of about 200 MeV for the diffractively produced pπ^- decay mode is implied. (auth)

59707 MOMENTUM DEPENDENCE OF THE 180° π^-p CHARGE-EXCHANGE CROSS SECTION. Kistiakowsky, V. (Massachusetts Inst. of Tech., Cambridge); Feld, B. T.; Triantis, F. A.; (and others). Phys. Rev., D; 6: No. 7, 1882-1905(1 Oct 1972).

The $\pi^- + p \rightarrow \pi^0 + n$ differential cross section at 180° was measured for 52 values of π^- momentum from 1.8 to 6.0 GeV/c using a constant-geometry detection system. The average statistical uncertainty is ~5% and the systematic uncertainty is ~10%. The details of the experiment and the data analysis are discussed. The data are compared with those of other experiments with which they are generally in agreement. One set of data disagrees with those presented here and a possible reason for this is discussed. A five-parameter fit of the predictions of a dual-resonance model to our data gave excellent agreement. The differential cross sections at 180° for $\pi^\pm$p elastic scattering are compiled and the moduli and relative phase of the $T = 1/2$ and $T = 3/2$ pion-nucleon s- and u-channel amplitudes ($|A_{1/2}|$, $|A_{3/2}|$, and $\cos\delta$) have a minimum at $\sqrt{u} = 0.4$ GeV/c and, in the s channel, a corresponding minimum at $\sqrt{s} = 2.2$ GeV/c. (auth)

59708 SPARK CHAMBER MEASUREMENT OF THE REACTIONS $\pi^\pm + p \rightarrow \rho^\pm + p$ AT 15 GeV/c. Pratt, J. C.; Kaune, W. T.; Lakin, W. L.; (and others) (Stanford Univ., Calif.). Phys. Lett.; 41B: No. 3, 383-6(2 Oct 1972).

A new method, using spark chambers, for the study of the reactions $\pi^\pm + p \rightarrow \rho^\pm + p$ is described. The charged pion and both γ rays from the $\rho^\pm$ decay are detected. Differential and integrated cross sections ($\sigma_\rho^+ = 50 \pm 9$ μb, $\sigma_\rho^- = 47 \pm 9$ μb) for $0.0 \leq |t| \leq 1.$ (GeV/c)^2 and a laboratory momentum (p_{Lab}) of 15 GeV/c are presented. The momentum dependence of $\sigma_\rho^\pm$ is well fitted from 2.7 to 16 GeV/c by $\sigma = K\,p_{Lab}^{-n}$ with $n_\rho^+ = 1.80 \pm 0.08$ and $n_\rho^- = 1.87 \pm 0.15$. (auth)

59709 INTERFERENCE BETWEEN (P,f^0,...) AND (ρ^0,B^0,...) EXCHANGES IN PION DIFFRACTION DISSOCIATION AT 16 Gev/c. Aachen-Berlin-Bonn-CERN-Heidelberg Collaboration. Phys. Lett., 41B: No. 3, 393-6(2 Oct 1972).

It is found in the reactions $\pi^\pm p \rightarrow (\pi^\pm\pi^+\pi^-)p$, believed to be dominated by diffraction dissociation, that the dσ/dt′ distributions show a "cross-over" effect at t′ ≈ 0.15, similar to the effect observed in elastic scattering. This gives evidence for the interference of (ρ^0,B^0,...) exchanges with (P,f^0,...) exchanges in pion diffraction dissociation reactions. No such evidence is found for baryon dissociation, $\pi^\pm p \rightarrow \pi^\pm(p\pi^+\pi^-)$, at the same energy. (auth)

59710 STRUCTURE OF THE BOSON MISSING-MASS SPECTRUM. Namiki, M.; Ohba, I. (Waseda Univ., Tokyo). Lett. Nuovo Cim.; 5: No. 3, 297-301(16 Sep 1972).

A possible threefold structure of the boson missing-mass spectrum of the process $\pi^- + p \rightarrow MM^- + p$ is examined using new data at initial energies of 25 and 45 GeV/c. Giant peaks corresponding to various meson resonance clusters are found in the spectrum. (J.F.P.)

59711 ABSORPTIVE MODEL AND REACTIONS $\pi^-p \rightarrow \rho p$, $\pi^-p \rightarrow \rho^0 n$ AT THE MOMENTUM 3.25 GeV/c. Guzhavin, V. M.; Dubovikov, M. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 16: No. 2, 411-15(Aug 1972). (In Russian).

A comparison between the experimental data and the predictions of the absorptive model is carried out. In theoretical calculations on the reaction $\pi^-p \rightarrow \rho^-p$ a contribution of diagrams with π^-- and ω-meson exchange was taken into account. The reaction $\pi^-p \rightarrow \rho^0 n$ is calculated within the framework of the OPEA model, with account of the background in S-state. From the experimental data the coupling constants $g_{\pi\rho\omega}$ and $g_{\pi\pi S}$ were determined, a comparison with the results from other work is presented. The calculations were carried out by the method developed by the authors earlier. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 59962, 59969, and 59984.

59712 (BNL—17203) ESTIMATE OF THE LIMIT OF THE BEAM—BEAM INTERACTION IN THE WEAK—STRONG LIMIT. Month, M. (Brookhaven National Lab., Upton, N. Y.). 14 Sep 1972. 5p. Dep. NTIS.

By reducing the effect of the beam—beam interaction in the weak-strong limit to a point cubic nonlinearity (octupole), an upper limit on the beam—beam interaction strength (in terms of the linear ν shift) is derived. To do this the numerical experiments of Gumowski are used. (auth)

59713 (NP—19454) EVALUATION OF PHASE SPACE INTEGRALS BY STATISTICAL METHODS AND APPLICATIONS WITH CUT IN TRANSVERSE MOMENTUM. Karimaeki, Veikko (Helsinki Univ. (Finland). Dept. of Nuclear Physics). 10 Dec 1971. 87p. Dep. NTIS (U. S. Sales Only).

Thesis.

A special method for the evaluation of the momentum phase space integrals is described. The method, based on the formation of statistical mechanics, has the restriction that the weight function $F(p_1, \ldots, p_n)$ must factorize in particle momenta. The case that weight function F only depends on the transverse momenta of the particles and factorizes is studied. F is chosen such that it gives the so-called transverse momentum cut-off. The corresponding numerical program is listed. Some physical consequences of the transverse momentum cut, especially total cross sections, average multiplicity and single particle distributions are discussed in some detail. (L.M.K.) (Finland)

59714 BOUNDS ON INCLUSIVE CROSS SECTIONS. Tiktopoulos, George (Rockefeller Univ., New York); Treiman, S. B. Phys. Rev., D; 6: No. 7, 2045-8(1 Oct 1972).

On the basis only of unitarity and certain limited analyticity assumptions inequalities are derived connecting single-particle inclusive data with elastic-scattering quantities. The high-energy behavior implied by these inequalities comes close to being saturated, on present evidence, to within logarithmic factors in energy. (auth)

59715 POSSIBLE METHOD OF SEARCHING FOR A WEAK NEUTRAL CURRENT IN $e^+ + e^- \rightarrow \mu^+ + \mu^-$. Cung, V. K. (Univ. of Pennsylvania, Philadelphia); Mann, A. K.; Paschos, E. A. Phys. Lett.; 41B: No. 3, 355-8(2 Oct 1972).

The possibility of observing interference between a weak interaction amplitude and an electromagnetic amplitude in the reaction $e^+e^- \rightarrow \mu^+\mu^-$ is enhanced by the expectation that the circulating e^+ and e^- beams in a storage ring are polarized. The salient features of a possible experiment, utilizing that polarization, which allows a search for a primitive weak neutral current to be made at high center-of-mass energy in that purely leptonic system are discussed. (auth)

59716 KINEMATICS OF INCLUSIVE EXPERIMENTS WITH UNSTABLE PARTICLES. Kopylov, G. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 41B: No. 3, 371-4 (2 Oct 1972).

The problem of reconstruction of the longitudinal or transverse momentum spectrum of π^0 mesons and that of detection of only one decay γ quantum is solved. Formulas for the moments of this distribution are derived. The results are generalized for arbitrary isotropic two- and three-particle decays. The Yen–Berger effect in the decay of resonances is estimated. (auth)

59717 QUASIPOTENTIAL FORMALISM FOR THE SPINS 0 AND 1/2 TWO-PARTICLE SYSTEM. Garsevanishvili, V. R.; Goloskokov, S. V.; Matveev, V. A.; Slepchenko, L. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 12: No. 3, 384-9(Sep 1972). (In Russian).

A quasipotential formalism for the particles with spin-0 and $-\frac{1}{2}$ was developed. The quasipotential equations for the scattering amplitude and the wave function were derived. (auth)

59718 FIERZ–PAULI EQUATION FOR PARTICLES WITH SPIN $\frac{3}{2}$. Bellissard, J.; Seiler, R. (Univ. de Provence, Marseille). Lett. Nuovo Cim.; 5: No. 3, 221-5(16 Sep 1972).

The difficulty with the Cauchy problem was circumvented by Velo and Zwanziger for several wave equations. Their method avoids the difficulty with the original equations, but some unsatisfactory aspects remain. Another difficulty arises for this method leaving the formal level and examining the Cauchy problem for the partial differential operators I_B and M_C in a function space. It is shown that M_C does not belong in general to either one of the classes of partial differential operators for which strong results are known about the existence and uniqueness of the Cauchy problem. Specifically the Fierz–Pauli equation for $s = \frac{3}{2}$ with minimal electromagnetic interaction is considered. The Rarita and Schwinger formalism is used. (J.F.P.)

59719 MATTER–ANTIMATTER SYMMETRY IN THE UNIVERSE. Krygier, B.; Krempec, J. (Univ. of Torun, Poland). Urania (Krakow); 43: 21-4(1972). (In Polish).

A symmetry between particles and antiparticles exists in the theory of elementary particles. May this symmetry be extended to the universe? Arguments for and against such a symmetry are surveyed, both from theory and from experiment. Thus a symmetric model of the universe was proposed by Alfvén and Klein. The main difficulty in this model is the exact mechanism of separation of matter from antimatter. A new mechanism was proposed recently by Defouw. Harrison gave arguments for a charge-symmetric universe; he started from initial fluctuations in baryon density. Experimental evidence for the existence of antimatter in the universe is obtained from gamma-ray astronomy, and from measuring certain abundances in cosmic radiation. According to Libby the average abundance of antimatter in the galaxy is less than 0.03 per cent. (auth) (NSA of Poland)

59720 EMPIRICAL RELATION FOR ELEMENTARY PARTICLES. Bhattacharjee, B. J. (St. Anthony's Coll., Shillong, India). Indian J. Phys.; 45: No. 12, 571-4(Dec 1971).

A mass relation among elementary particles was obtained with a new quantum number. The equation for almost all elementary particles is found by a curve fitting process, as $Y = -152.08 + 139.07X - 6.2478X^2 + 0.15223X^3 - 0.0019593X^4 + 0.00001269X^5 - 0.000000033X^6$. (auth)

59721 CORRELATIONS IN SEMI-INCLUSIVE CROSS SECTIONS. Koba, Z.; Olesen, P. (Univ. of Copenhagen). Nuovo Cim.; 11A: No. 3, 774-84(1 Oct 1972).

Cross sections for semi-inclusive experiments of the type $a + b \rightarrow c(p_1) + \ldots + c(p_j) + (n - j)$ charged + anything neutral are considered. A set of correlation functions for these cross sections are defined. These correlation functions satisfy the natural boundary condition that, if the inclusive correlations are absent, then the semi-inclusive correlations are also absent, and vice versa. The generating functional recently introduced by various authors is expressed in terms of semi-inclusive correlation functions. The set of semi-inclusive cross sections is expressed in terms of inclusive cross sections. (auth)

59722 PREDICTIONS FOR THE HIGHER MOMENTS OF THE CHARGED-PARTICLE MULTIPLICITY DISTRIBUTION. Gupta, V. (Tata Inst. of Fundamental Research, Bombay). Lett. Nuovo Cim.; 5: No. 1, 108-11(2 Sep 1972).

The consequences of the charge conservation constraints for the third and higher moments of the charged particle multiplicity distribution are investigated. It is found that the distribution is Poisson in $\frac{1}{2} N_c$. (L.B.S.)

59723 FACTORIZATION IN π^- INCLUSIVE REACTIONS IN THE CENTRAL REGION. Choudhury, S. Rai (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 5: No. 1, 7-8(2 Sep 1972).

Various features of the data on inclusive reactions in the central or pionization region for π^- and π^+ production compiled by Ferbel are considered. In particular, it is pointed out that Mueller's assumption of factorizable Regge poles would imply a certain relationship between the slopes of the various reaction cross sections given in Ferbel's paper. These relations and their validity for the case of π^- inclusive processes are examined. (L.B.S.)

59724 GEL'FAND–YAGLOM EQUATIONS WITH CHARGE OR ENERGY DENSITY OF DEFINITE SIGN. Amar, V.; Dozzio, U. (Univ., Parma, Italy). Nuovo Cim.; 11A: No. 1, 87-100 (1 Sep 1972).

Finite-dimensional Gel'fand–Yaglom equations are considered; the supplementary requirement is imposed such that, for half-odd spin, the charge density, and for integer spin, the energy density be positive definite. In general, a necessary condition to satisfy this requirement is derived in terms of a restriction on the structure of the Gel'fand chains. For equations with unique mass and spin this necessary condition is shown to be also sufficient. Connections with previous works on relativistic wave equations are discussed. (4 figures) (auth)

59725 CONNECTION OF THE TOTAL CROSS SECTION WITH THE DIFFRACTION PEAK OF ELASTIC SCATTERING. Savrin, V. I.; Semenov, S. V.; Tyurin, N. E.; Khrustalev, O. A. (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 16: No. 2, 384-8(Aug 1972). (In Russian).

In the framework of two models of elastic scattering, the relation, that establishes a correlation between the energy dependence of elastic and total cross sections and the width of a diffraction cone, is considered. (auth)

59726 ADVANCED COMPUTING METHODS IN THEORETICAL PHYSICS. VOLUME 1. Second Colloquium Held in Marseille, France, June 21, 1971. Marseille; Centre National de la Recherche Scientifique ([1971]). vp. (CONF-710655–(Vol.1)).

The conference included 12 papers. Separate abstracts were prepared for each paper. (J.F.P.)

For abstracts of individual papers see: 59789, 59824, 59881, 59882, 59905, 59983, 59984, 60034, and 60511–60514.

Electromagnetic

Refer also to abstracts 59682, 59923, 59945, 59975, 60006, 60007, 60101, and 60485.

59727 (DESY–72/44) PION ELECTROPRODUCTION AND PHOTOPRODUCTION INCLUDING PCAC. Dombey, Norman; Read, B. J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Aug 1972. 43p. Dep. NTIS (U. S. Sales Only).

The PCAC constraints on pion electroproduction and photoproduction are considered in order to construct models applicable to these processes at low and high energies. In particular the roles of the nucleon axial vector form factor and the pion electromagnetic form factor are investigated. (auth)

59728 (FRNC-TH–219) PHOTON EMISSION IN e^+e^- REACTIONS. Martin, Francois (Paris Univ., Orsay (France)). 1971. 68p. (In French). Dep. NTIS (U. S. Sales Only). Thesis.

The α^3 radiative corrections due to photons emitted by the initial electrons in an e^+e^- process yielding an undefined final state, f (not containing electrons) were determined. The cross section for this process is calculated in the one-photon-exchange approximation. The validity of the approximation for quasi-real phenomena under ultrarelativistic conditions was studied. It is shown that the conditions necessary for this approximation to be completely valid for the differential cross section are not realizable in the storage rings (an error of 14% can be reached). On the other hand, the approximation is completely valid for the total cross section measured using storage rings. (France)

59729 (LBL—967) LOCALIZATION OF PHOTONS. Clauser, John F. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1972. Contract W-7405-eng-48. 17p. (CONF-720646—1). Dep. NTIS.

From third Rochester conference on coherence and quantum optics; Rochester, NY. (21 Jun 1972).

Various experiments suggesting a localization of photons are reviewed, and it is shown that they are not in conflict with a simple wave description. The Lamb and Scully semiclassical treatment of the photoelectric effect is discussed, and a situation in which its predictions are in conflict with those of a usual quantum mechanical treatment of the electromagnetic field is described. The difference is found in the localizability of electromagnetic emissions. Finally, the requirements for a conclusive experiment are derived, and existing experimental tests are reviewed but found inconclusive. (J.F.P.)

59730 (NP—19452) NEW DUALITY RESULTS FOR THE PROTON—NEUTRON ELECTROPRODUCTION STRUCTURE FUNCTION DIFFERENCE. Gehlen, G. v.; Wessel, H.; Rubinstein, H. R. (Bonn Univ. (West Germany). Physikalisches Institut). Sep 1972. 8p. Dep. NTIS (U. S. Sales Only).

It is shown that the s-channel resonance contributions build up the $I_t = 1$ Compton amplitude in the deep inelastic region. This is done by using ω_W-scaling to relate the low energy photo- and electroproduction data and theory to the SLAC-MIT proton-neutron structure function difference measurements. (auth)

59731 MODIFIED ABFST MODEL AND ω-SCALE BREAKING AS $q^2 \rightarrow 0$ IN INELASTIC ELECTRON SCATTERING AND RELATED PROCESSES. Dash, J. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B47: No. 1, 269-85(1972).

A gauge-invariant ladder model for the pomeron in inelastic electron scattering is presented in which the ω-scale breaking mass m_0 for small q^2 is identified as being somewhat smaller than the ω-meson mass. The main parameter in the model is an average transverse momentum cut-off. Using reasonable values, $m_0^2 \approx 0.4$ GeV^2 and $\sigma_L/\sigma_T \approx 15\%$ at $q^2 = -1$ GeV^2 are obtained. Approximate scaling in the variable $\nu/(m_0^2 - q^2)$ is achieved if the $\omega\gamma\pi^0$ form factor $F_{\omega\gamma\pi}(q^2)$ behaves like $(1 - q^2/0.8)^{-1/2}$ for $q^2 \leq 0$. A Veneziano model for $F_{\omega\gamma\pi}(q^2)$ satisfying this with one additional free parameter is constructed. Consistency with $\sigma(e^+e^- \rightarrow 2\pi)$, $\sigma_{\gamma N}^{tot}$, and the two $t \approx 0$ cross sections for $\gamma p \rightarrow \rho^0 p$ and $\gamma p \rightarrow \omega^0 p$ is obtained. The ρ^0 electroproduction cross section is predicted to fall off somewhat faster in q^2 than inelastic electron scattering in addition to t_{min} effects, and does not scale. The Gell-Mann—Sharp—Wagner model for $\Gamma(\omega^0 \rightarrow 3\pi)$, $\Gamma(\omega^0 \rightarrow \pi^0\gamma)$ and $\Gamma(\pi^0 \rightarrow 2\gamma)$ is brought into agreement with experiment. The q^2 dependence of photon inclusive processes in the target fragmentation region is predicted. It is argued that the total $e^+e^- \rightarrow$ hadrons cross section can be made to behave as $1/q^2$. The model does not contradict parton or Veneziano models or the light cone algebra for small ω scaling. Also a quasi-separable formula for $e^J_{\lambda\mu}(z)$ useful for analyzing partial wave equations with spin is proven. A separable kernel approximation is used to obtain nonasymptotic q^2 information. (auth)

59732 POSSIBLE MASS ANISOTROPY AND INTERACTION OF ULTRA-HIGH-ENERGY PARTICLES WITH ELECTROMAGNETIC FIELD. Sazonov, V. I. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 15: No. 5, 1060-8(May 1972). (In Russian).

Particles are considered with inertial properties described by a relativistic tensor m_i^k which is not proportional to Kronecker symbol: $m_i^k = m\delta_i^k + \Delta m_i^k$ (i, k = 0, 1, 2, 3). A classical electrodynamics for such particles (particles with the anisotropic mass) is constructed. It turns out that the dynamics and the particle—photon interaction for ultra-high-energy particles with Lorentz-factor $\gamma = (1 - (\nu^2/c^2))^{-1/2} = 10^{11}$ which were observed in cosmic rays will be considerably changed already at the degree of the anisotropic $\Delta m_0^0/m \sim \gamma^{-2} = 10^{-22}$ that is many orders less than the upper laboratory limit 10^{-12} for $\Delta m_0^0/m$. (auth)

59733 ATOMIC DECAYS OF ELEMENTARY PARTICLES. Nemenov, L. L. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 5, 1047-50(May 1972). (In Russian).

Elementary particle decays being accompanied by an atomic system production were considered. The relative probabilities are calculated for the decays: $\pi^0 \rightarrow \gamma + (e\bar{e})$-atom, $\eta^0 \rightarrow \gamma + (e\bar{e})$-atom, $\eta^0 \rightarrow \gamma + (\mu\bar{\mu})$-atom. A relation is noted between the π^0-meson life time and relative probability for a positronium observation from the $\pi^0 \rightarrow \gamma + (e\bar{e})$ decay. (auth)

59734 FIXED POLE IN THE VIRTUAL COMPTON-EFFECT AMPLITUDE. Rakov, Yu. A.; Tsarev, V. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 15: No. 5, 1032-4(May 1972). (In Russian).

The contradiction with the fixed pole in the amplitude of the real and virtual Compton-effect on a nucleon is shown to be naturally removed in a model of complex P′- and A_2-poles. (auth)

59735 CURRENT ALGEBRA AND THE PROBLEM OF DIVERGENCE COMPENSATION IN $\Delta T = 2$ ISOTOPIC MASS DIFFERENCES. Kaganovich, A. B. (Chita State Pedagogical Inst., USSR). Yadern. Fiz.; 15: No. 5, 1009-15(May 1972). (In Russian).

With the use of the asymptotic Bjorken expansion, a possibility is investigated of obtaining finite values for $\Delta T = 2$ isotopic mass differences. The calculations are carried out in the lowest order in the electromagnetic and weak interactions. The sufficient condition for the simultaneous removal of the logarithmic and quadratic divergences is shown to be the use of the extended field algebra which contains Lee, Weinberg and Zumino field algebra model as its component. In this case, the intermediate boson mass is equal to $M_w \approx 55$ GeV. (auth)

59736 ELECTROMAGNETIC INTERACTION OF MUON AND $K_L \rightarrow 2\mu$ DECAY. Grigoryan, G. V.; Nikolaev, N. N.; Okun, L. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 15: No. 5, 995-8(May 1972). (In Russian).

The breakdown of muon electrodynamics is considered as a possible cause of the suppression of $K_L \rightarrow 2\mu$ decay rate. (auth)

59737 SCATTERING BY TWO CHARGED CENTERS. Li, Ming Chiang (Virginia Polytechnic Inst. and State Univ., Blacksburg). J. Math. Phys. (N. Y); 13· No. 9, 1381-6(Sep 1972).

The scattering of a charged particle by two fixed charged centers is discussed. The scattering potential is long-range and spheroidal. It is pointed out that the general method for handling the short-range spheroidal potential is not directly applicable. The integral differential equation for the Coulomb spheroidal phase shift is given. The behavior of the phase shift is discussed in Born's approximation. A method for solving for the radial spheroidal Coulomb wavefunction is also given. (auth)

59738 VENEZIANO-LIKE REPRESENTATION FOR THE PION FORM FACTOR. Pratap, Mahendra (State Univ. of New York, Stony Brook). Phys. Rev., D; 6: No. 7, 2043-4(1 Oct 1972).

A simple Veneziano-like representation for the pion form factor is related to the two-pion unitarity equation and the Veneziano formula for the π-π scattering amplitude. Some further approximations to the unitarity equation are also discussed. (auth)

59739 RESONANCE CONTRIBUTIONS, RADIATIVE WIDTHS, AND STRAY BARYONIC STATES IN $K^+\Lambda$ PHOTOPRODUCTION. Deans, S. R.; Jacobs, D. T.; Lyons, P. W.; Montgomery, D. L. (Univ. of South Florida, Tampa). Phys. Rev., D; 6: No. 7, 1906-16(1 Oct 1972).

The reaction $\gamma p \rightarrow K^+\Lambda$ below 2.2-GeV cm energy was analyzed using an isobar model. Energy-dependent multipoles are parametrized by a Breit—Wigner resonance form with an unknown phase included on the coupling. Evidence is found for the existence of a $D_{13}(1670)$ resonant state with a width of about 100 MeV. In addition to the $D_{13}(1670)$, other important states below 1.9 GeV are the $S_{11}(1700)$, $P_{11}(1750)$, and $P_{13}(1860)$. Approximate values are obtained for the radiative widths of these states. (auth)

59740 FOUR-PHOTON DECAY OF THE NEUTRAL PION. Schult, R. L. (Univ. of Illinois, Urbana); Young, B.-L. Phys. Rev., D; 6: No. 7, 1988-92(1 Oct 1972).

The decay rate for $\pi^0 \rightarrow 4\gamma$ is estimated to order α^4 in several models and found to be considerably suppressed by the angular momentum barriers required by gauge invariance and even further suppressed in models satisfying a partially-conserved-axial-vector-current condition. Typical values for $\Gamma(\pi^0 \rightarrow 4\gamma)/\Gamma(\pi^0 \rightarrow 2\gamma)$ range from 4×10^{-14} to 10^{-18}. It is concluded that the dominant contribution is likely to come from an electron-loop diagram contributing in order α^8 but without angular momentum barriers. (auth)

59741 DERIVATION OF NEUTRAL-PION MOMENTUM SPECTRA FROM PHOTON MOMENTUM SPECTRA. Glasser, R. G. (Argonne National Lab., Ill.). Phys. Rev., D; 6: No. 7, 1993-5(1 Oct 1972).

The spectrum of neutral-pion momentum (projected on an arbitrary axis) can be measured by measuring the corresponding component of the individual photon spectrum. The only assumption required is that the photons are predominantly produced from the pion decay. (auth)

59742 COHERENT CONTRIBUTION TO THE BREAKING OF BJORKEN'S SCALING LAW FOR SMALL Q^2 AND A TRANSVERSE-MOMENTUM DISTRIBUTION IN THE PARTON MODEL.

Yoshii, H.; Kitani, K. (Tokyo Inst. of Tech.). Phys. Rev., D; 6: No. 7, 1945-52(1 Oct 1972).

The parton model for the inelastic lepton-hadron scattering is generalized in the region of small momentum transfer squared Q^2. $\nu W_2(X,Q^2)$ is calculated including the coherent contribution as well as the incoherent one. In this Q^2 region, the coherent contribution, which is subtractive, becomes of the same order as the incoherent one. Then $\nu W_2(X,Q^2)$ calculated in this way does not exhibit the scaling behavior as observed in recent experiments. The data on inelastic e-p scattering are compared with numerical calculation assuming the transverse-momentum distribution of the partons to be Gaussian. (auth)

59743 STUDY OF THE ELECTROMAGNETIC STRUCTURE OF DELTA(1236) VIA PHOTO- AND ELECTRODISINTEGRATION OF THE DEUTERON. Nath, N. R.; Weber, H. J. (Univ. of Virginia, Charlottesville). Phys. Rev., D; 6: No. 7, 1975-87 (1 Oct 1972).

The deuteron photo- and electrodisintegration processes $\gamma d \rightarrow \Delta\Delta$ and $ed \rightarrow e\Delta\Delta$ are shown to be probes of the electromagnetic properties of $\Delta(1236)$, on the basis of a Δ-exchange-reaction mechanism. The presence of the $\Delta\Delta$ configuration in the deuteron, with an estimated probability of 1%, yields a photon cross section of the order of 1 μb at 1 to 2 GeV photon energy. (auth)

59744 POSSIBILITY OF MEASURING MESON AND BARYON ELECTROMAGNETIC-STRUCTURE FUNCTIONS USING NAL AND ISR. Pancheri-Srivastava, G. (CNEN, Frascati, Italy); Srivastava, Y. N. Lett. Nuovo Cim.; 5: No. 2, 202-6(9 Sep 1972).

The possibility of using the very high-energy accelerators (e.g., NAL) to measure the $\pi^{\pm}$, $K^{\pm}$ electromagnetic form factors and the inelastic structure functions is suggested. It is demonstrated that by considering a reasonably large transfer-momentum cutoff the electromagnetic cross section dominates over the strong one, and is large enough to be measured. It is also pointed out that by performing a slightly different experiment the meson electromagnetic form factors can be obtained. (L.B.S.)

59745 FORWARD SLOPE IN PHOTOPRODUCTION AND ELECTROPRODUCTION OF ρ^0. Avni, Y. (Stanford Univ., Calif.). Lett. Nuovo Cim.; 5: No. 2, 182-6(9 Sep 1972).

The dual-absorptive model is applied to the process $\gamma p \rightarrow \rho^0 p$ near the forward direction. It is demonstrated, using an inductive approach, that the observed differential cross section $(d\sigma/dt)_0$ and the forward slope S may be obtained by a shrinking pomeron + peripheral f. (L.B.S.)

59746 TWO PHOTONS TERMS IN e^+e^- ANNIHILATION INTO $\pi\pi$ AND $K\bar{K}$. Lepetre, Y.; Renard, F. M. (Department de Physique Mathematique, Montpellier, France). Lett. Nuovo Cim.; 5: No. 2, 117-24(9 Sep 1972).

The contribution of two-photon diagrams with the formation of C = +1 resonances in $e^+e^- \rightarrow \pi^+\pi^-$ and $e^+e^- \rightarrow K\bar{K}$ interactions is calculated in an attempt to explain the high cross-section results at Novosibirsk and Frascati. It is concluded that the two-photon terms will not enhance notably the cross sections in the 1 to 2 GeV region, unless the fVV of f′VV coupling constants are anomalously large. It is suggested that a precise measurement of the behavior of the cross section between 1 and 2 GeV is necessary in order to see if one has to deal with a series of resonance effects (higher vector mesons or C = +1 resonances) or with a smooth background. (L.B.S.)

59747 PHOTON—HADRON INTERACTIONS. I. International Summer Institute in Theoretical Physics, Hamburg, Germany, July 12—24, 1971. Hoehler, G. (ed.). Springer Tracts in Modern Physics, Volume 62. Berlin; Springer-Verlag (1972). 151p. $18.40. (CONF-710734—(Pt.1)).

Separate abstracts are prepared for the nine papers included in this volume. (L.B.S.)

For abstracts of individual papers see: 59748—58752, 59811, 59862, 59897, and 59967.

59748 CANONICAL LIGHT-CONE COMMUTATORS AND THEIR APPLICATIONS. Jackiw, Roman (Massachusetts Inst. of Tech., Cambridge). Springer Tracts Mod. Phys.; 62: 1-28 (1972).

From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

Recent work on the canonical structure of the commutators of currents on the light cone is reported and applications to electroproduction processes and to fixed-mass sum rules are discussed. (L.B.S.)

59749 DUALITY IN DEEP INELASTIC ELECTROPRODUCTION. Landshoff, P. V. (Cambridge Univ., Eng.). Springer Tracts Mod. Phys.; 62: 37-50(1972).

From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

The concept of duality for deep inelastic electroproduction is discussed in terms of the quark-parton model, muon-pair production, and Veneziano-like models. (L.B.S.)

59750 DUALITY FOR REAL AND VIRTUAL PHOTONS. Rubinstein, Hector R. (Weizmann Inst. of Science, Rehovot, Israel). Springer Tracts Mod. Phys.; 62: 72-91(1972).

From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

Some known and new results are reviewed and discussed. Particular emphasis is given to questions concerning the possibility that electroproduction and photoproduction are more closely connected than expected. The kinematics and limiting properties of the structure functions are first discussed. The concept of duality is then introduced and discussed in the context of fixed q^2 mm rules. Analyticity and local duality in the whole ν-q^2 plane are discussed. The extent to which duality is locally obeyed is discussed, and by introducing an appropriate scaling variable, a connection is found with photoproduction. Properties of the neutron-proton structure functions difference are analyzed. Questions concerning the time-like region are briefly mentioned, and predictions that will test the model in depth are discussed. The relevance of these results under the light of currently available models is discussed in conclusion. (L.B.S.)

59751 SCALING IN DEEP INELASTIC SCATTERING WITH FIXED FINAL STATES. Rittenberg, V. (Weizmann Inst. of Science, Rehovoth, Israel). Springer Tracts Mod. Phys.; 62: 92-7(1972).

From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

The application of light cone expansion of operator products for one-particle electroproduction is illustrated for the scattering of scalar photons on scalar equal-mass isospinless particles. It is assumed that the general structure obtained in the Bjorken limit will provide a stringent test of the validity of the operator expansions. The procedure is generalized to many particle production processes. (L.B.S.)

59752 DUALITY AND THE PION ELECTROMAGNETIC FORM FACTOR. Huang, Kerson (Massachusetts Inst. of Tech., Cambridge). Springer Tracts Mod. Phys.; 62: 98-106(1972).

From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

The following model for the pion electromagnetic form factor that combines duality and current algebra requirements is explored: Only pion pairs are coupled to a photon through the elementary vertex $e(p_2-p_1)\mu$. All other charged particles are coupled to the photon in a non-elementary way, namely by first becoming a pion pair via the strong interactions. (L.B.S.)

59753 PHOTON—HADRON INTERACTIONS. II. International Summer Institute in Theoretical Physics, Hamburg, Germany, July 12—24, 1971. Hoehler, G. (ed.). Springer Tracts in Modern Physics, Volume 63. Berlin; Springer-Verlag (1972). 193p. $24.80. (CONF-710734—(Pt.2)).

Separate abstracts are prepared for the seven papers included in this volume. (L.B.S.)

For abstracts of individual papers see: 59754—59758, 59828, and 59863.

59754 HIGH ENERGY PHOTOPRODUCTION OF PSEUDOSCALAR MESONS. Froyland, J. (Inst. of Physics, Oslo). Springer Tracts Mod. Phys.; 63: 1-30(1972).

From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

Various models used to study high-energy photoproduction of pseudoscalar mesons are discussed in general. Absorption-type models are then considered in more detail. The kinematics for $\gamma N \rightarrow 0^- \, {}^1\!/_2{}^+$ is presented. The remaining discussion is devoted to the construction of models for π^0, η, π^+, π^-, and K production. 65 references. (L.B.S.)

59755 SOME ASPECTS OF VECTOR MESON PHOTOPRODUCTION ON PROTONS. Schilling, K. (CERN, Geneva). Springer Tracts Mod. Phys.; 63: 31-56(1972).

From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

Some recent models on diffraction dissociation of photons are reviewed that go beyond simple vector meson dominance of the final state by including nonresonant diffractively produced background. (auth)

59756 VECTOR MESON DOMINANCE, PHOTO- AND ELECTROPRODUCTION FROM NUCLEONS. Schildknecht, D. (DESY, Hamburg). Springer Tracts Mod. Phys.; 63: 57-97(1972).
From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

The basic assumptions of the vector dominance model are first reviewed. The following topics are then discussed: the γ_ρ, γ_ω, and γ_ϕ coupling constants; single pion and $\pi\Delta(1236)$ photoproduction and electroproduction; vector meson dominance predictions from smoothness of invariant amplitudes; photoproduction and electroproduction of vector mesons, and the total electroproduction cross section. 121 references. (L.B.S.)

59757 $\rho-\omega$ MIXING. Renard, F. M. (Faculte des Sciences, Montpellier, France). Springer Tracts Mod. Phys.; 63: 98-120 (1972).

The mixing formalism appropriate for overlapping resonances is reviewed. Models for the mixing parameter are discussed. The application of the mixing formalism to ρ and ω decays, e^+e^- interactions, and vector meson photoproduction is presented. (L.B.S.)

59758 EXOTIC ELECTROMAGNETIC CURRENTS. Donnachie, A. (Univ. of Manchester, Eng.). Springer Tracts Mod. Phys.; 63: 121-44(1972).
From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

The existence of exotic electromagnetic currents is examined, and two particular aspects of exotic behavior are considered, namely that the electromagnetic current has a C-violating component and that either or both of the C-conserving and C-violating currents have an isotensor, as well as the usual isoscalar and isovector components. The features examined are the presence of high isospin and high spin, which can be found in the $\Delta N\gamma$ vertex. Four situations in which this vertex plays a role are considered in detail, namely pion photoproduction and π radiative capture in the first resonance region; deuteron photodisintegration and neutron—proton radiative capture; inelastic electron scattering off a polarized target in the region of the first resonance; and the neutron electric dipole moment. (L.B.S.)

59759 RADIATION OF A CHARGED PARTICLE MOVING ALONG A HELICAL PATH IN A TRANSPARENT ANISOTROPIC MEDIUM. Kukanov, A. B.; Orisa, B. D. Opt. Spectrosc. (USSR) (Engl. Transl.); 32: No. 2, 185-6(Feb 1972).
Translated from Opt. Spektrosk.; 32: No. 2, 351-4(Feb 1972).

The Sitenko—Kolomenskii method is used to determine the electric-field intensity of the radiation of a charged particle moving in a helical path in a transparent uniaxial crystal. The radiation loss of the particle is calculated. For the special case of motion along the optic axis at a constant velocity $\nu_{||}$, the equation obtained coincides with the known result for the intensity of Vavilov—Cherenkov radiation. For another special case of uniform motion along a circle in a vacuum, we find the well-known Schott result. The method presented is also used as the basis for a discussion of the problem of radiation of a charged particle during unidimensional uniformly accelerated (hyperbolic) motion in a constant electric field in a vacuum. A formula is obtained for the spectral-angular distribution of radiation, and the polarization of this radiation is also investigated. (auth)

59760 SOME OBSERVATIONS ON THE INELASTIC ELECTRON–NUCLEON SCATTERING DATA. Breidenbach, M.; Kuti, J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(11-1)-3069. Phys. Lett.; 41B: No. 3, 345-9(2 Oct 1972).

A compact phenomenological description of the proton data in inelastic electron—nucleon scattering is suggested here. The practical applications of the data analysis are briefly discussed. (auth)

59761 PARTON DESCRIPTION OF THE FORWARD PEAK IN SINGLE PARTICLE ELECTROPRODUCTION WITH HIGHLY VIRTUAL PHOTONS. Roy, Probir (Tata Inst. of Fundamental Research, Bombay). Phys. Lett.; 41B: No. 3, 325-8(2 Oct 1972).

The parton mode for the reaction eN → eAB (N = nucleon, A, B = hadrons) in the fixed ω Bj limit is used to discuss the width of the corresponding forward peak as a function of the photon mass. (auth)

59762 CONNECTION OF THE DEUTERON ELECTRODISINTEGRATION MATRIX ELEMENT WITH THE NEUTRON–PROTON PHASE SHIFTS. Trubnikov, S. V. (Inst. of Mathematics, Moscow). Teor. Mat. Fiz.; 12: No. 3, 390-6(Sep 1972). (In Russian).

The representation for the transition matrix element $\langle np|j^\mu|d\rangle$ derived previously is used, in which the contribution of the anomalous and kinematical cuts is separated and expressed via the physical scattering matrix. The representation makes it possible to describe the deuteron structure as well as the outgoing nucleons in the unified manner. The final-state interaction is treated exactly. No arbitrary subtraction constants enter the final result. (auth)

59763 QUATERNIONIC SOLUTIONS FOR THE RELATIVISTIC KEPLER PROBLEM WITH MAGNETIC CHARGES. Feneuille, S.; Crubellier, A. (Centre National de la Recherche Scientifique, Orsay, France). J. Phys., A (London); 5: No. 7, 944-9(Jul 1972).

The relativistic Kepler problem in Dirac form is solved by means of a quaternionic method for particles having both electric and magnetic charges. The variables in spherical coordinates can be separated in a simple way, and the results obtained are similar to those which are valid for the usual hydrogen atom. (auth)

59764 AUTOMODEL ASYMPTOTICS IN QUANTUM FIELD THEORY. II. Bogolyubov, N. N.; Tavkhelidze, A. N.; Vladimirov, V. S. (Inst. of Mathematics, Moscow). Teor. Mat. Fiz.; 12: No. 3, 305-30(Sep 1972). (In Russian).

The process of deep inelastic scattering of electrons by protons, the probability of which is expressed in terms of the imaginary part of the amplitude of the virtual Compton effect is considered. It is proved that the form factors W_1 and W_2 are causal and the Jost—Lehmann—Dyson representation can be used for them. Some restrictions on the weight functions of this representation leading to the automodel asymptotics of the deeply inelastic amplitude are found. With these restrictions the current commutator behavior near the light cone is derived, and a connection between the singularities on the light cone and the asymptotic behavior of the form factors is established. (auth)

59765 STUDY OF HIGH ENERGY (25 TO 10,000 GeV) INTERACTIONS WITH A MULTIPLATE CLOUD CHAMBER USING MONTE CARLO SIMULATIONS FOR ENERGY CALIBRATION. Vatcha, R. H.; Sreekantan, B. V.; Tonwar, S. C. (Tata Inst. of Fundamental Research, Bombay). J. Phys., A (London); 5: No. 6, 859-76(Jun 1972).

Monte Carlo simulations of hadron and electron—photon cascades in the large multiplate cloud chamber operating at Ootacamund (India) were carried out using some plausible interaction models. Some extreme assumptions about multiplicity and inelasticity were incorporated in order to study their effect on the detailed features of the cascades. A new method for estimating the energies of the cascades of energy above about 200 GeV by measuring "cascade widths" at different depths in the absorber was developed with calibrations provided by the simulations. The estimated energy is accurate to within 50%. The experimentally observed cascades due to pions and nucleons at energies below 200 GeV are similar and a comparison of the detailed profiles with the simulated cascades suggests that pions like nucleons are only partially inelastic at these energies. Hadron cascades in the TeV energy range show rather fast absorption after the cascade maxima. This feature suggests the possibility of an increase in inelasticity and multiplicity, or an increase in the fraction of energy transferred to the soft component in TeV collisions of hadrons with iron nuclei, compared to these characteristics at lower energies. (auth)

59766 HIGH ENERGY PHOTOPRODUCTION OF π^+ AND HAMA–IWAKI–SOKAWA–SUZUKI MODEL. Kishi, Yosuke (Ehime Univ., Matsuyama, Japan); Yano, Tadashi; Shiohara, Masao. Ehime Daigaku Kiyo, Dai-3-Bu, Kogaku; 7: No. 2, 13-22(Mar 1971).

Using an absorption model of distorted wave Born approximation type, the reaction $\gamma p \to \pi^+ n$ (abbreviated as $\gamma\pi^+$ hereafter) was analyzed, taking contribution of ρ-meson exchange into account in addition to pion exchange and proton pole. In this case, in order to obtain agreement with experiment, coupling constant of $\gamma\rho\pi$ vertex G $\gamma\rho\pi$ had to be taken as energy dependent. Recently a new model for the high energy quasi-two body reaction was proposed by Hama, Iwaki, Sokawa and Suzuki to remedy the wrong energy dependence. The possibility of explaining the $\gamma\pi^+$ process at high energy with the constant G $\gamma\rho\pi$ according to the HISS model and validity of this model was examined. Neglecting electromagnetic interaction, the partial wave transition amplitude takes a very simple form. The coupling constants of ρ-meson to nucleon and to pion used in the present analysis were determined. Furthermore, total cross section and slope of forward peak of differential cross section of scattering were given. The result of the numerical calculation was compared with experiment. Theoretical values are about 100 to 1,000 times as large as those of the experiment, due to a correction factor, while calculated values of the differential cross section in the unmodified Born amplitude alone are about the same as experimental ones in the forward direction. The simple HISS model does not reproduce the high energy data of the photoproduction of π^+. As for the validity of HISS model, it seems that the calculated energy dependence of cross section cannot reproduce the energy dependence of the experimental cross section decreasing rapidly with energy. (Japan)

59767 TRIPLE-REGGE FORMULAE IN PHOTO- AND ELECTROPRODUCTION. Dias de Deus, J.; Pham Xuan Yem (Institut de Physique Nucleaire, Paris). Phys. Lett.; 41B: No. 3, 359-63 (2 Oct 1972).

In the spirit of the duality hypothesis of Freund and Harari a triple-Regge-like formula is used to interpret and parametrize the data in photo- and electroproduction of vector mesons in the presence, or not, of a background. The (missing mass)^2, (photon mass)^2, and (p−p momentum transfer)^2 dependences of the $e + p \rightarrow e + p + X$ cross section are given and compared with experiments. An explanation is proposed for the (apparently) conflicting existing data. (auth)

59768 ELECTRON–POSITRON ANNIHILATION INTO HADRONS AT HIGH ENERGIES. Cheng, H. (Massachusetts Inst. of Tech., Cambridge); Wu, T. T. Contract AT(11-1)-3227. Phys. Lett.; 41B: No. 3, 375-8(2 Oct 1972).

In the limit of extremely high energies with the transverse momentum of each hadron fixed, the reaction $e^+ + e^- \rightarrow$ hadrons proceeds by the annihilation of this pair into two virtual photons which turn into two fireballs of hadrons with negligible final-state interaction. (auth)

59769 THEORY OF THE LONGITUDINAL DEVELOPMENT OF ELECTROMAGNETIC CASCADES. Thielheim, K. O.; Zoellner, R. (Univ., Kiel). J. Phys., A (London); 5: No. 7, 1054-72(Jul 1972).

A method for the numerical integration of the cascade equations of the longitudinal development of electromagnetic cascades is described. Numerical results on the longitudinal development of electron-induced cascades in lead are presented in graphical form. Comparisons with data from Monte Carlo simulations and with experimental data are presented. The accuracy of approximations A and B of conventional cascade theory is investigated. (auth)

59770 SIMPLE MODEL FOR PION PAIR PHOTOPRODUCTION AMPLITUDE. Blasi, A.; Collina, R. (Univ., Genoa). Nuovo Cim.; 11A: No. 3, 676-86(1 Oct 1972).

A nonrelativistic solvable model for the pion pair photoproduction amplitude on a single nucleon is proposed. The results obtained give a parametrization of the amplitude itself, which clarifies analogous parametrizations currently employed in the literature. (auth)

59771 ANGULAR CORRELATIONS IN THE ELECTROPRODUCTION OF ρ-MESONS. Dieterle, B. (Stanford Univ., Calif.). Nuovo Cim.; 11A: No. 3, 523-42(1 Oct 1972).

Electroproduction of ρ-mesons followed by decay into two pions is studied. Angular correlations between the pions and electrons are explicitly evaluated. It is shown how a separation of the longitudinal and transverse photon cross sections can be achieved. Distributions which allow a separation of the transverse and longitudinal photon cross-sections are emphasized. (auth)

59772 MODEL AMPLITUDES FOR e^+e^- ANNIHILATION INTO PIONS AT HIGH ENERGIES. Craigie, N. S.; Kraemmer, A. B.; Rothe, K. D. (Univ., Heidelberg). Nuovo Cim.; 11A: No. 3, 645-64(1 Oct 1972).

The high-energy limit of e^+e^- annihilation into hadrons is studied within the framework of Feynman graphs, by supposing that the virtual photon couples to a hadronic system via a pair of elementary hadrons. The role played by the topology of the graphs in determining the distribution of the final-state particles in the multidimensional phase space is studied, using ϕ^3 theory as a tool. In these models there emerge two competing phenomena analogous to "pionization" and "fragmentation" in two-body hadronic production processes. The effect of including spin and internal-symmetry requirements is studied for the special example of the peripheral production of three pions off a fermion loop. Specific predictions of this model are discussed. (auth)

59773 APPLICATION OF THE SU$_4$ BILOCAL CURRENT ALGEBRA TO THE INCLUSIVE REACTIONS $e + N \rightarrow e +$ SOFT PION + ANYTHING AND $e + N \rightarrow e + \gamma +$ ANYTHING. Koca, M. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 5: No. 1, 59-65(2 Sep 1972).

Sum rules and structure function relations for inclusive reactions virtual $\gamma + N \rightarrow \pi^+(\text{soft}) + X$ and virtual $\gamma + N \rightarrow \gamma + X$ are derived using the light-cone algebra of the bilocal currents abstracted from the four-quark picture. (L.B.S.)

59774 K^+ PHOTOPRODUCTION AND THE F/D RATIO FOR VECTOR- AND TENSOR-MESON COUPLINGS TO BARYONS. Alonso, J. L.; Schiff, D.; Tran Thanh Van, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Lett. Nuovo Cim.; 5: No. 1, 27-33(2 Sep 1972).

It is shown that it is not possible to describe K^+ photoproduction data $\gamma p \rightarrow K^+(\Lambda,\Sigma)$ with a conventional absorptive-cut model applied to K^*-K^{**} absorbed exchanges. A good quantitative agreement is obtained, when including the K contribution, which turns out to be substantial in the forward direction for $\gamma p \rightarrow K^+ \Lambda$. The F/D ratio for vector- and tensor-meson couplings to baryons and predictions are given for the up-down asymmetry from a polarized nucleon P and for the asymmetry with polarized photons. The sign of P is fixed with SU(3) and the vector-dominance model; a qualitative agreement with the data is found. (L.B.S.)

59775 HADRONIC PHONONS. Orfanidis, S. J. (Yale Univ., New Haven). Contract AT(30-1)-2726. Lett. Nuovo Cim.; 5: No. 1, 97-100(2 Sep 1972).

The inelastic-excitation function $\nu W_2(\nu,q^2)$ of the proton is determined in a thermodynamic model where the hadron is considered as a system of noninteracting quasi-particles or phonons, with the requirement that there are essentially no quasi-particles of the system with momenta greater than the dynamical cut-off of ~400 MeV/c. (L.B.S.)

59776 RESOLUTION OF THE SU(3) PUZZLE: $\Gamma(\eta \rightarrow \gamma\gamma)/\Gamma(\pi^0 \rightarrow \gamma\gamma)$. Fischbach, Ephraim (Purdue Univ., Lafayette, Ind.); Nieto, Michael Martin; Primakoff, Henry; Scott, C. K. Phys. Rev. Lett.; 29: No. 15, 1046-9(9 Oct 1972).

By using the Duffin–Kemmer–Petiau (DKP) description of mesons, simple SU(3) theory is rendered consistent with the supposedly "large" experimental value of $\Gamma(\eta \rightarrow \gamma\gamma)/\Gamma(\pi^0 \rightarrow \gamma\gamma) = 129 \pm 33$. After a discussion of $\eta-\eta'$ mixing a prediction [uncertain because of large errors in $\Gamma_{tot}^{expt}(\pi^0)$ and $\Gamma_{tot}^{expt}(\eta)$] of $\Gamma^{DKP}(\eta' \rightarrow \gamma\gamma) = 0.32^{+0.99}_{-0.32}$ keV is made. This is at least 1 to 2 orders of magnitude lower than the Klein–Gordon (KG) prediction, $\Gamma^{KG}(\eta' \rightarrow \gamma\gamma) = 52 \pm 24$ keV, which in fact is almost ruled out by upper limits set by recent experiments. (auth)

59777 DIPOLE FORM FACTORS. Hagen, C. R. (Univ. of Rochester, N. Y.); Sudarshan, E. C. G. Phys. Rev. Lett.; 29: No. 15, 1044-5(9 Oct 1972).

It is shown that a mechanism recently proposed by Hammer and Weber to obtain dipole behavior for the nucleon electromagnetic form factors is incorrect. (auth)

59778 NEUTRON AND PROTON FORM FACTORS. Goebel, C. J. (Univ. of Wisconsin, Madison). Phys. Rev. Lett.; 29: No. 15, 1042-3(9 Oct 1972).

The conclusions of a paper of the above title by Hammer and Weber, recently published in this journal, are criticized. (auth)

59779 ANALYSIS OF THE ANNIHILATION REACTION $\bar{p}p \rightarrow 2\pi^+2\pi^-$ AT 3.6 GeV/c IN TERMS OF A MULTIPERIPHERAL MODEL INCLUDING RESONANCES. de la Vaissiere, Ch. (LPNHE, Paris). Nuovo Cim.; 11A: No. 1, 185-206(1 Sep 1972).

The annihilation reaction $\bar{p}p \rightarrow 2\pi^+2\pi^-$ at 3.6 GeV/c appears to proceed through intermediate channels involving meson resonances ρ^0, f^0, g^0. The multi-Regge model of Chan, Loskiewicz, and Allison (CŁA), which is found to give a good description of pion distributions such as cms angles and momenta, is inadequate for resonance formation. The introduction of resonances in the CŁA model by Plahte and Roberts leads to a rather poor description of the data, and gives no information on the branching ratios of the intermediate states. An attempt is made to introduce the resonances in the CŁA model by considering that they can be coupled to the nucleon Regge trajectory in the same way as pions through phenomenological coupling constants. Then, the amplitudes of all the multiperipheral graphs that can be drawn are added incoherently. This phenomenological model introduces one extra parameter/resonance relative to the original CŁA model. It may be extended to higher multiplicities. This sum of amplitudes approximates well the physical situation at 3.6 GeV/c, equally for pion and multipion distributions as for resonance formation. A straightforward extrapolation of the model to 1.2 and 5.7 GeV/c leads only to minor discrepancies. (13 figures, 3 tables) (auth)

59780 SIMPLE METHOD FOR COMPUTING ELECTRODYNAMIC PROCESSES OF HIGH ORDER. Parisi, G. (CNEN, Frascati, Italy); Zirilli, F. Nuovo Cim.; 11A: No. 1, 37-44 (1 Sep 1972).

A general method for evaluating Feynman graphs is proposed; the method avoids the calculation of very long traces. The exact differential cross section for the contribution of two-photon annihilation to the process $e^+e^- \rightarrow e^+e^-e^+e^-$ is given, where the Fermi statistics for the final particles are taken into consideration. The polarization effects on these cross sections are also computed. (2 figures) (auth)

59781 BREMSSTRAHLUNG SPECTRUM OF ULTRARELATIVISTIC ELECTRONS IN A DENSE MEDIUM. Varfolomeev, A. A.; Bazylev, V. A.; Zhevago, N. K. (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 3, 820-30(Sep 1972). (In Russian).

The bremsstrahlung radiation from high energy electrons in a dense absorbing medium is investigated. It is shown that variation of the electron multiple scattering constant due to specific energy losses results in additional suppression of the radiation as compared to the usual multiple scattering effect. The possibility of separating the total energy losses of an ultrarelativistic electron in absorbing media into bremsstrahlung and direct formation of electron–positron pairs is considered. Analytic expressions for the bremsstrahlung spectrum are obtained by taking into account virtual quantum absorption, medium polarization and multiple scattering with a varying constant. (auth)

59782 SCATTERING OF LIGHT BY LIGHT. Isaev, P. S.; Khlaskov, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.); 16: No. 3, 134-6(5 Aug 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 3, 190-3(5 Aug 1972).

Previous expressions for the reaction $\gamma + \gamma \to 2\pi$ were used to calculate the s and d waves of the scattering of light by light using dispersion relations. The cross sections of these waves are found. The amplitudes and contribution of the process $\gamma + \gamma \to K + \bar{K}$ to the $\gamma + \gamma \to \gamma + \gamma$ reaction are found. The cross section for the $\gamma + \gamma \to \gamma + \gamma$ is shown qualitatively. The cross section for the reactions $e + e \to 2e + 2\gamma$ is found. The differential cross section for this process is related to the cross section for the scattering of light by light. (J.F.P.)

59783 CALCULATIONS IN ELECTRON–PHOTON SHOWERS CAUSED BY 50 TO 400 MeV ELECTRONS AND γ-QUANTA IN Pb. Borkovskii, M. Ya.; Kruglov, S. P. (Inst. of Nuclear Physics, Leningrad). Yadern. Fiz.; 16: No. 2, 349-57(Aug 1972). (In Russian).

The probabilities of observing the given number of charged particles at various depths of the absorber and of energy distribution in it are calculated with the Monte Carlo method for the showers, caused by 100 to 800 mc^2 electrons and γ-quanta. Electrons and positrons were traced down to 3 mc^2 and γ-quanta—down to 1 mc^2. Possible reasons for disagreement between these results and those in other work are indicated. Distribution of the absorbed energy near the shower axis is in better agreement with the experimental data than the results obtained previously. (auth)

59784 RADIATIVE CORRECTIONS FOR THE CROSS SECTION OF ep-SCATTERING AT SMALL ANGLES WHEN DETECTING RECOIL PROTON. Vanzha, A. P.; Gevorkyan, S. P.; Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 16: No. 2, 358-61(Aug 1972). (In Russian).

Radiative corrections are calculated for the cross section of ep-scattering at small angles ($q^2 \sim 0.01 - 0.02$ GeV/c^2) detecting recoil protons. In this the maximum mass squared of the system of undetectable particles m^2_{max} may be compared with 4-momentum transfer. The formulas are given for the case when detector efficiency is 100% and when it is an angular function. (auth)

59785 QUASIREAL PHOTON APPROXIMATION FOR DESCRIBING ELECTROPRODUCTION PROCESSES. Baier, V. N.; Fadin, V. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 63: No. 3, 761-9(Sep 1972). (In Russian).

A general approach is formulated for describing two-photon electroproduction processes ($e^\pm e^- \to e^\pm e^- + N$) under conditions when only particles produced with a small total transverse momentum are observed. It is shown that in this case a number of amplitude combinations for the $\gamma + \gamma \to N$ process can in principle be determined, one of them being the cross section for the nonpolarized photon photoprocess; the others enter the cross section for the photoprocess involving linearly polarized photons. (auth)

59786 APPLICABILITY OF THE WEIZSACKER–WILLIAMS APPROXIMATION FOR TWO-PHOTON PARTICLE PRODUCTION. Budnev, V. M.; Ginzburg, I. F.; Meledin, G. V.; Serbo, V. G. (Novosibirsk State Univ., USSR). Yadern. Fiz.; 16: No. 2, 362-6(Aug 1972). (In Russian).

It is shown, that the usual approximation in the method of the equivalent photons is not applicable to some cases for the differential cross sections of the two-photon particle production, and its generalization was obtained. The accuracy for an approximation was estimated. The accuracy is higher than logarithmic one in some cases considered. The application of this method is considered for obtaining the lower estimations for the cross sections. (auth)

59787 AMPLIFIED DIRAC EQUATION AND ITS REDUCTION TO THE PAULI FORMALISM. Hanus, W.; Mrugala, R. (Nicholas Copernicus Univ., Torun, Poland). Acta Phys. Pol.; B3: No. 4, No. 4, 437-41(1972).

Covariant and Hamiltonian forms of the Dirac equation (for a charged particle in an external electromagnetic field) amplified by the Pauli terms were investigated in connection with the problem of reduction to the subspace of positive energy states. (auth)

59788 NEW DIRAC EQUATIONS. Kapuscik, E. (Inst. of Nuclear Physics, Krakow). Acta Phys. Pol.; B3: No. 4, 451-8 (1972).

A general class of wave equations is considered which as a special case contains the new wave equations proposed by Dirac. It is shown that it is possible to introduce the interaction with an external electromagnetic field if we choose different members of the considered class. A particular case of such wave equations is treated in some detail. (auth)

59789 ALGORITHMS FOR THE GAMMA-ALGEBRA OF ELECTROMAGNETIC FORM FACTORS. Chisholm, J. S. R. (Kent Univ., Canterbury, Eng.). pp 1.1-1.11 of Advanced Computing Methods in Theoretical Physics. Vol. 1. Marseille; Centre National de la Recherche Scientifique (1971).

From second conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655—(Vol.1).

A set of algorithms for evaluating the form factor contributions from any allowable combination of γ-matrices contributing to a vertex part is presented. (France)

59790 ALGEBRAIC AND ANALYTIC TECHNIQUES FOR THE SIXTH ORDER RADIATIVE CORRECTIONS TO THE ANOMALOUS MAGNETIC MOMENTS OF THE ELECTRON AND MUON. Levine, M. J. (Carnegie-Mellon Univ., Pittsburgh); Wright, Jon. pp 4.28-4.61 of Advanced Computing Methods in Theoretical Physics. Vol. 2. Marseille; Centre National de la Recherche Scientifique (1971).

From second conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655—(Vol.2).

The present theoretical and experimental situation concerning the evaluation of the sixth-order contribution of the vertex graphs to the anomalous magnetic moments of the electron and muon are briefly reviewed. The general procedures used to reduce the problem to quadratures are presented: the machine implementation of the algebraic work is described. The removal of nonintegrable uv and ir singularities is described and the numerical integration is briefly examined. (France)

59791 ANALYTIC COMPUTER ASSISTED EVALUATION OF THE DISCONTINUITIES OF THE ELECTRON FORM FACTORS AT FOURTH ORDER IN QED. Barbieri, R. (Scuola Normale Superiore, Pisa, Italy); Remiddi, E. pp 4.77-4.114 of Advanced Computing Methods in Theoretical Physics. Vol. 2. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655—(Vol.2).

Methods recently used to evaluate the fourth order discontinuities of the two form factors corresponding to the electromagnetic vertex functions of the electron in the quantum electrodynamics perturbation series expansion are presented. The results obtained are given. The analytical calculation was performed for some arbitrary values of momentum transfer. The Shoonschip program was used. The case of a two-body cut graph and a three-body cut graph is successively examined. (France)

Weak

Refer also to abstracts 59923, 59925, 59986, and 60013.

59792 (DESY–72/42) "EXOTIC" HADRON WEAK CURRENTS. Oakes, R. J.; Primakoff, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jul 1972. 6p. Dep. NTIS (U.S. Sales Only).

It is briefly described how appropriate neutrino experiments can provide tests for the presence in the hadron weak current of a strangeness-conserving isotensor component as well as a strangeness-changing isospin-$^3/_2$ component. The processes $\nu_\mu + N$ and $\bar{\nu}_\mu + N$ with $\Delta^{++}(1236)$ production, $\bar{\nu}_\mu + N$ with strangeness-changing current for Σ^* production, and the reactions ν + ^{4}He and μ^- capture by ^{4}He with isotensor component in strangeness-conserving hadron weak current are discussed. (J.F.P.)

59793 (FRNC-TH-220) THEORETICAL INVESTIGATION OF FORM FACTORS IN K_{l3}. Sazdjian, Hagop (Paris Univ., Orsay (France)). [nd]. 125p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The general theory of the weak semi-leptonic interaction is reviewed and the phenomenology of the K_{l3} decay is presented. The analyticity properties of the form factors, the resulting dispersion relations, and the approximations used for the absorption parts are studied. The ksi parameter is investigated from the solutions of the Omnes equation. It is shown that it is impossible to obtain a value of ksi near to -1, when the form factor $f_0(s)$ does not pass through zero and the $K\pi$ scattering amplitude is normal. In view of taking singularities in the high energy region into consideration, the form factors are assumed to possess a finite number of poles. The hypothesis is made that an analogy exists between the asymptotic behavior of the imaginary part of the form factors and that of the scattering amplitudes of the Regge theory. It is found that the imaginary parts of the π electromagnetic form factor and the f + form factor of K_{l3} tend rapidly to zero in the asymptotic regions; on the other hand f_0 is consistent with a substraction in a dispersion relation. The model predicts two solutions in ksi, one of which corresponds to ksi of the order of ±1. The parametrization of the amplitude and form factors for $K\pi \rightarrow k\pi$ interactions are also studied. (France)

59794 (JINR–D2-6637) STRUCTURE OF SOME MATRIX ELEMENTS IN CURRENT COMMUTATORS. Bogolyubov, P. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 24p. Dep. NTIS (U. S. Sales Only).

The Fourier transforms of current commutators were earlier represented in terms of scalar functions. It was shown that these functions can be chosen such that they should be causal. This result is extended to more general cases. (auth)

59795 (JINR–E2-6645) CONSTRAINTS GIVEN BY THE ATMOSPHERIC NEUTRINO INDUCED MUON FLUX ON THE NEUTRINO NUCLEON INTERACTIONS AT HIGH ENERGIES. Kunszt, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 60p. Dep. NTIS (U. S. Sales Only).

It is shown that from the measured neutrino-induced muon flux one can derive constraints on the neutrino nucleon interactions at high energies. It is pointed out that if the structure functions in the deep inelastic νN scattering exhibit scale invariant behavior then the slope(c) of the total νN cross section ($\sigma = cE$) is necessarily less than 0.8 in agreement with predictions of gluon-quark parton models. If intermediate vector boson exists then at 3 standard deviations $m_w > 2$ GeV. (auth)

59796 SUGGESTED EXPERIMENTAL TEST OF CP NONINVARIANCE IN $K^0 \rightarrow \pi^+\pi^-\gamma$. Beder, D. S. (Univ. of British Columbia, Vancouver). Nucl. Phys.; B47: No. 1, 286-90(1972).

Measurable quantities in the K^0 weak-electromagnetic decays are looked for which would be useful indicators of CP invariance or noninvariance, and it is concluded that decay correlations in $K_L \rightarrow \pi\pi\gamma$ offer the best diagnostic opportunity. (auth)

59797 DEEP INELASTIC LEPTON PAIR PRODUCTION IN A NEUTRINO–NUCLEUS SCATTERING. Lev, F. M. (Moscow physical-Technical Inst.). Yadern. Fiz.; 15: No. 5, 999-1001 (May 1972). (In Russian).

The main double–logarithmic contribution to the cross section of the $\nu Z \rightarrow \nu Z + (\bar{l}l)$ process is calculated for the large momentum region. (auth)

59798 SINGLE HYPERON PRODUCTION AND $\frac{3}{2}^+$ DECUPLET WEAK DECAYS. Nikolaev, N. N. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 15: No. 5, 981-4(May 1972). (In Russian).

The $\Delta T = \frac{1}{2}$ rule and octet enhancement predictions for $\frac{3}{2}^+$ decuplet weak decays were obtained. A possibility of their checking by means of single hyperon production reactions is discussed. (auth)

59799 PARITY-NONCONSERVING $\Delta S = 0$ NONLEPTONIC WEAK PROCESSES IN THE PRESENCE OF SECOND-CLASS CURRENTS. Herczeg, P. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., D; 6: No. 7, 1934-7(1 Oct 1972).

The possibility that currents with irregular charge-conjugation properties are present in the standard CP-invariant current × current nonleptonic weak Hamiltonian is considered. It is pointed out that the parity-violating $n \rightarrow p\pi^-$ amplitude is not determined then by the strangeness-changing amplitudes alone and may be considerably larger than in the conventional theory. (auth)

59800 SIMPLE BOUND FOR K_{l3} DECAY PARAMETERS USING THE πK ($s = 0$, $T = \frac{1}{2}$) PHASE SHIFT. Micu, M.; Radescu, E. E. (Inst. of Atomic Physics, Bucharest). Phys. Rev., D; 6: No. 7, 1943-4(1 Oct 1972).

Taking as known the value of the propagator of the divergence of the weak strangeness-changing vector current at zero momentum transfer ($t = 0$) and the phase of the K_{l3} form factor d(t) in the elastic region (where it is given by the phase of the $s = 0$, $T = \frac{1}{2}$ πK scattering), a simple bound for $d'(0)$ is found which gives a stronger restriction on the K_{l3} parameters than the one originally obtained by Li and Pagels. (auth)

59801 TEST FOR SCALAR-BOSON-MEDIATED WEAK-INTERACTION THEORIES IN HIGH-ENERGY NEUTRINO-SCATTERING PROCESSES. Krishna, S. (Indian Inst. of Tech., Kanpur). Phys. Rev., D; 6: No. 7, 1957-60(1 Oct 1972).

Pais and Treiman have shown that in neutrino-scattering processes lepton-pair locality implies explicit dependence of the cross section on two-lepton-system variables. It is suggested here that violation of their theorem occurring to the first order in the weak-interaction coupling constant in the scalar-boson-mediated theories may serve as an unambiguous test at energies much smaller than those required for production and subsequent tests on the weak bosons. In a typical model substantial violations of the lepton-energy-dependence theorem are found. On the contrary, violation of the angle-dependence theorem is small. (auth)

59802 CONSISTENT SOLUTION TO THE K_{l3} PROBLEM IN THE $(3,\bar{3})$ MODEL. Danskin, J. H. (Harvard Univ., Cambridge, Mass). Phys. Rev., D; 6: No. 7, 2062-7(1 Oct 1972).

It is shown that the $(3,\bar{3})$ model can provide a consistent solution to the K_{l3} problem, provided that $\lambda_+ \approx 0.08$. Although only one experiment has given this result at the present time, it is only in this region that the following criteria can be satisfied simultaneously: (i) $\xi(0)$ is close to the experimental mean of -0.65, (ii) $f_+(0)$ is within 10% of unity, i.e., second-order SU(3) corrections are small, (iii) the vacuum is approximately SU(3)-invariant, (iv) the mass of the κ meson lies in the region where there is some experimental evidence for such a particle, and (v) the Callan–Treiman relation is reasonably well satisfied. It is also pointed out that in some earlier solutions where a much lower value of λ_+ was fitted, an important inequality involving $f_+(0)$ and m_κ was violated, thus rendering these models inconsistent. (auth)

59803 COMMENT ON A QUARK MODEL OF THE WEAK INTERACTION. Penner, R. L. (Univ. of Toronto). Phys. Rev., D; 6: No. 7, 2059-62(1 Oct 1972).

To improve the agreement with experiment a modification is made to a renormalizable SU(4)-symmetry model of the weak interaction. The quantum numbers of the new symmetry are electron and muon lepton numbers and first and second baryon numbers. A value for the intermediate boson mass is calculated assuming that the weak and electromagnetic interactions conspire to produce a finite lepton-mass renormalization. (auth)

59804 CALCULATION OF THE SECOND-ORDER WEAK AMPLITUDE FOR $K_2 \rightarrow \pi^0 e^+ e^-$. Sehgal, L. M. (Technische Hochschule, Aachen). Phys. Rev., D; 6: No. 7, 2014-17(1 Oct 1972).

The second-order weak amplitude for $K_2 \rightarrow \pi^0 e^+ e^-$ has a finite imaginary part arising from the presence of a $\pi\nu$ intermediate state in the channels $K_2 + e^\pm \rightarrow \pi^0 + e^\pm$, which is calculated in terms of the amplitudes for $K_2 \rightarrow \pi^\mp e\ \nu$ and $\pi^\pm \rightarrow \pi^0 e^\pm \nu$. The real part is determined by means of a dispersion relation, and the result converges for a simple choice of the K_{2e3} and π_{e3} form factors. (auth)

59805 K^0–$\bar{K}^0$ STATES IN A K_L–K_S PHENOMENOLOGICAL S MATRIX. Kumar, Sudhir (Univ. of Notre Dame, Ind.). Phys. Rev., D; 6: No. 7, 2000-3(1 Oct 1972).

It is shown that for a CPT-invariant S matrix which treats K_S and K_L states as overlapping resonances, K^0 and $\bar{K}^0$ states can always be defined which are consistent with the usual phenomenology. In particular the unitarity and CPT analysis of the $K_L \rightarrow \mu^+\mu^-$ puzzle are contained in such a phenomenological S matrix. (auth)

59806 ELASTIC NEUTRINO–PROTON SCATTERING WITH STRONG W-BOSON INTERACTIONS. Appelquist, Thomas; Goldman, Terrence (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 6: No. 7, 2048-51(1 Oct 1972).

A lower bound on the high-energy behavior of elastic neutrino-proton scattering is estimated in a theory in which W bosons have strong pairwise interactions with hadrons. The W-pair-exchange process gives a first-order weak contribution to this cross section which grows as the square of the neutrino energy. (auth)

59807 GAUGE-INVARIANCE RESTRICTIONS ON POLE MODELS FOR $K_L \rightarrow \gamma\gamma$ DECAY. McKay, Douglas W.; Munczek, H. J. (Univ. of Kansas, Lawrence). Phys. Rev., D; 6: No. 7, 2040-3(1 Oct 1972).

Within the usual pole-model assumptions which have been employed for calculating the $K_L \rightarrow \gamma\gamma$ decay, it is shown that gauge invariance excludes K*-pole graphs and allows only the π^0- and η-pole contributions. (auth)

59808 LIGHT-CONE APPROACH TO STRUCTURE FUNCTIONS IN A THEORY OF WEAK AND ELECTROMAGNETIC INTERACTIONS. Riazuddin (Daresbury Nuclear Physics Lab., Eng.); Fayyazuddin. Phys. Rev., D; 6: No. 7, 2032-9(1 Oct 1972).

Light-cone algebra is written for the currents in a unified theory of weak and electromagnetic interactions, and is used to obtain predictions for deep-inelastic structure functions of $\nu + N \rightarrow \nu +$ anything in terms of those of $e + N + e +$ anything and/or $\nu_1 + N \rightarrow 1 +$ anything. The predictions are characteristic of the theory because of the existence in the theory of a neutral strangeness-conserving weak hadronic current which couples with a neutral lepton current, whereas in the conventional theory with only charged currents the process $\nu + N \rightarrow \nu +$ anything does not occur in the lowest order. (auth)

59809 TESTING WEAK-INTERACTION MODELS IN $e^+e^- \rightarrow \mu^+\mu^-$. Love, A. (Rutherford Lab., Chilton, Eng.). Lett. Nuovo Cim.; 5: No. 2, 113-16(9 Sep 1972).

It is pointed out that the transverse polarization of electrons and positrons in storage rings, which results from synchrotron radiation, will be a great advantage in testing proposed models of the weak interaction where the leptons couple to a neutral intermediate vector boson as well as a charged one. It is suggested that a particularly suitable process for the measurement will be $e^+e^- \rightarrow \mu^+\mu^-$. The Weinberg model is considered, and the polarization of the muons produced in $e^+e^- \rightarrow \mu^+\mu^-$ at $\theta = \pi/2$, $\phi = 0$ is calculated. (L.B.S.)

59810 MESON-DOMINANCE MODEL FOR THE WEAK-INTERACTION HAMILTONIAN AND THE PARITY-VIOLATING MESON–NUCLEON COUPLING. Ragutt, B.; Schuelke, L. (Ruhr-Univ., Bochum, Ger.). Lett. Nuovo Cim.; 5: No. 2, 187-91(9 Sep 1972).

A meson-dominance model is proposed for the weak-interaction Hamiltonian. The longitudinal and transverse parts of the weak currents are replaced by the corresponding spin-0 and spin-1 mesons, respectively. It is shown that the cos $^2\theta$ part leads to a vanishing direct πNN vertex and to a ρNN vertex as given by the factorization approximation, while from the sin $^2\theta$ part the strength of the πNN coupling can be estimated and the result is of the same order of magnitude as that obtained from the chiral algebra treatment supplemented with SU(3) arguments. (L.B.S.)

59811 PARTON MODELS OF INELASTIC LEPTON SCATTERING. Smith, C. H. Llewellyn (Stanford Univ., Calif.). Springer Tracts Mod. Phys.; 62: 51-71(1972).

From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

Some preliminary remarks are given on the kinematics and scale invariance of highly inelastic lepton scattering. The usual derivation of the parton model is outlined; it is then shown how the results can be rederived formally using infinite-momentum commutators. Brief remarks are given on the use of local duality in inelastic lepton scattering. (L.B.S.)

59812 CALCULATION OF THE INDUCED PSEUDOTENSOR TERM IN Λ BETA DECAY. Pritchett, P. L.; Deshpande, N. G. (Northwestern Univ., Evanston, Ill.). Phys. Lett.; 41B: No. 3, 311-14(2 Oct 1972).

The size of the induced pseudotensor form factor $g_2(0)$ arising from SU(3) symmetry breaking for the decay $\Lambda \rightarrow p + e^- + \nu_e$ is estimated. Saturation of the unsubtracted dispersion relation for $g_2(0)$ with the lowest-mass two-particle states yields a value at least an order of magnitude smaller than that suggested by recent experiments. Implications of this result for the existence of second-class currents are discussed. (auth)

59813 LIGHT-CONE COMMUTATORS, PION AMPLITUDES, AND K_{13} DECAY. Furlan, G. (Univ., Trieste, Italy); Paver, N. Nuovo Cim.; 11A: No. 3, 543-56(1 Oct 1972).

Starting from SU_3 SU_3 light-cone commutators a sum rule is derived for K_{13} decay. The dispersive path in the plane of the independent scalar variables is a straight line depending, essentially, on m_π, m_K. The SU_3 and $SU_2 \otimes SU_2$ symmetry limits, corresponding to the fixed-mass configuration, are discussed. (auth)

59814 ELECTROMAGNETIC EFFECTS IN $K \rightarrow 2\pi$ DECAYS. Bailin, D. (Univ. of Sussex, Brighton, Eng.). Nuovo Cim.; 11A: No. 3, 725-32(1 Oct 1972).

Under the assumption that the Hamiltonian responsible for nonleptonic weak decays satisfies the $|\Delta I| = 1/2$ rule and has the usual vector-current-axial-vector-current symmetry, an attempt is made to estimate the electromagnetic effects in the $K \rightarrow 2\pi$ decays in the symmetrized soft-pion limit. A prediction for the $K^+ \rightarrow \pi^+\pi^0$ to $K_s^0 \rightarrow 2\pi$ branching ratio is obtained which agrees well with experiment. However, the deviations from the $|\Delta I| = 1/2$ rule for K_s^0 decays induced by electromagnetism could be predicted. (auth)

59815 NONLEPTONIC HYPERON DECAYS IN A CURRENT–CURRENT QUARK MODEL. Koerner, J. G. (Univ., Heidelberg); Gudehus, T. Nuovo Cim.; 11A: No. 3, 597-617(1 Oct 1972).

A current-current quark model is used to describe the parity-violating and parity-conserving nonleptonic decay modes of the octet baryons and the Ω^--particle. The SU_3 transformation property of the nonleptonic transitions induced by the current-current quark Hamiltonian is discussed in terms of the commutation rules of the underlying quark fields. Fermi quarks do not lead to a satisfactory description of the data. Using paraquarks and a slightly modified current-current paraquark Hamiltonian a reasonable fit is made to the existing data in terms of three parameters. A close analogy of the model to the usual current algebra calculation is exhibited. (auth)

59816 K_{13} FORM FACTORS AND THE KAPPA-MESON. Bhargava, A. K. (Indian Inst. of Tech., Kanpur). Lett. Nuovo Cim.; 5: No. 1, 66-8(2 Sep 1972).

Recent measurements of the K_{13} form factors give $\xi = -0.62 \pm 0.28$, whereas most of the models predict a small negative $\xi \sim -0.2$. It is shown that, if currents are taken in field-current identity form and symmetry breaking does not modify currents, it is not possible to explain the large ξ within the framework of the effective Lagrangian approach. (L.B.S.)

59817 μ^--MESON CAPTURE BY A POLARIZED-PROTON TARGET. Kerimov, B. K.; Samsonenko, N. V. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 5, 12-20(1972). (In Russian).

The differential capture cross sections of randomly polarized and unpolarized μ^- mesons by a polarized proton target were calculated for very low order V, A, P-interactions. The presence of a pseudoscalar interaction in an effective Hamiltonian leads to an angular distribution of neutrons emitted upon capture of randomly polarized muons by a polarized proton target. For energetic right-polarized μ^- mesons, the capture cross section by unpolarized, and also polarized protons is proportional to G^2. This may be utilized for determining the intensity and sign of a pseudoscalar interaction. In a $(V-\lambda A)$ variant of interaction of muon and nucleon fluxes, predictions of two-component and four-component theories of the neutrino differ. (tr-auth)

59818 QUALITATIVE FEATURES OF THE LEPTON SPECTRA IN THE PROCESS OF W-BOSON PRODUCTION IN A NEUTRINO BEAM. Makeev, V. V.; Nevskii, P. L.; Nikitin, Yu. P.; (and others) (Moscow Engineering Physics Inst.). JETP Lett. (USSR) (Engl. Transl.); 16: No. 3, 125-8(5 Aug 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 3, 180-3(5 Aug 1972).

The properties of the reaction $\nu_\mu + N \rightarrow \mu^- + W^+ + N$ are studied. A relation is given for establishing the existence of the W particle and the measurement of its mass. The doubly differential cross sections were calculated for the production of μ^- and l^+ leptons, and the neutrino spectrum, coherent W production, and effects of nucleon Fermi motion and μ^- mass on the cross sections and l^+ spectra amplitude are discussed. (J.F.P.)

59819 PROBLEM OF THE $K_L \rightarrow 2\mu$ DECAY AND μ-MESIC ATOMS. Zahkarov, V. I.; Okun, L. B. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 2, 70-2(20 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 2, 102-5(20 Jul 1972).

The limitations that can be obtained from data on μ-mesic atoms for the constants g_i of the four-fermion muon–nucleon interactions, which were suggested as a possible reason for the experimental nonobservation of the decay $K_2^0 \rightarrow 2\mu$, are discussed. The shift and the fine and hyperfine splitting of the levels are considered. (J.F.P.)

59820 WEAK INTERACTION OF PHOTONS AND ELASTIC νe ($\bar{\nu}e$) SCATTERING. Gnedov, Yu. A.; Romanov, Yu. I. (Sterlitamak State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 138-40(1972). (In Russian).

Attempts to detect anti-neutrino-electron scattering are involved with the reactions $\nu + e^- \rightarrow \nu + e^-$, and $\bar{\nu} + e^- \rightarrow \bar{\nu} + e^-$ in completely different hypotheses concerning the interaction between a neutrino (anti-neutrino) and electrons. These two reactions were investigated further under the assumption that they may be realized on account of a four-fermion and hypothetical reaction—a weak interaction of a neutrino with a photon. (K.S.W.)

59821 CORRECTIONS FOR WEAK INTERACTION IN $K \rightarrow l^+l^-$, $K \rightarrow \pi l^+l^-$ DECAYS. Shabalin, E. P. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 16: No. 2, 367-75 (Aug 1972). (In Russian).

Using as an example the simple model of weak interaction with violation of CP-invariance the role of the second-order effects in weak interactions in $K \rightarrow l^+l^-$ and $K \rightarrow \pi l^+l^-$ decays is studied. An account for the second-order corrections allows one to narrow the difference between the theoretical and experimental values of the $K_L \rightarrow \mu^+\mu^-$ decay probability. In $K^+ \rightarrow \pi^+e^+e^-$ decays the contribution of the second-order weak interactions may considerably determine the decay picture. $K \rightarrow l^+l^-$ and $K \rightarrow \pi l^+l^-$ decays are also considered in the framework of renormalized theory of weak interactions, and some limitations on the parameters of such a theory are derived. (auth)

59822 $K_L \rightarrow 2\mu$ DECAY AND POSSIBILITY OF LIGHT VECTOR MESON EXISTENCE. Dolgov, A. D.; Dolgolenko, A. G.; Zakharov, V. I.; Okun, L. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 16: No. 2, 376-83(Aug 1972). (In Russian).

A hypothesis, according to which a negative experimental result on searching for $K \rightarrow 2\mu$ decay is due to existence of light vector meson χ_0 is discussed. It is shown that the hypothesis contradicts the experimental data available. (auth)

59823 CURRENT ALGEBRA SUM RULES, VENEZIANO MODEL, AND K_{l3} FORM FACTORS. Dominguez, C. A. (Stanford Linear Accelerator Center, Calif.); Zandron, O. S. Nuovo Cim.; 11A: No. 1, 13-22(1 Sep 1972).

The K_{l3} form factors $f_\pm(t)$ are obtained by means of current algebra dispersive sum rules. After introducing a simple Veneziano formula with satellites for the relevant amplitudes and using the normalization $f_+(0) = 1$, an expression with no free parameters is found for both $f_\pm(0)$. In the decay region they turn out to be $f_+(t) = 1 + 0.06(t/m_\pi^2)$, $f_-(t) = -1.7(1 + 0.02(t/m_\pi^2))$. Thus, the model predicts the following values for the K_{l3} parameters: $\xi(0) = -1.7$, $\lambda_+ = 0.06$, $\lambda_- = 0.02$, and $\Lambda = 0.07$. The agreement with experiment is found to be excellent. (auth)

59824 NUMERICAL SOLUTION OF LIPPMANN–SCHWINGER EQUATION AND ITS APPLICATION TO ETA AND $K \rightarrow 3\pi$ DECAYS. Graves-Morris, P. R. (Kent Univ., Canterbury, Eng.). pp 2.34-2.42 of Advanced Computing Methods in Theoretical Physics. Vol. 1. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655–(Vol.1).

An economical method of solving the Lippmann–Schwinger equation in the scattering region is presented. This is tantamount to solving the Schroedinger equation with the boundary conditions built in. The method for finding the eigenfunctions of the T-matrix at fixed energy is described and a model of eta and $K \rightarrow 3\pi$ decays which embodies pairwise final-state interactions driven by Yukawa potentials is also presented. (France)

Strong (General)

Refer also to abstract 59950.

59825 THEORY OF POLARIZATION SHIFTS IN EXOTIC ATOMS. Ericson, T. E. O. (CERN, Geneva); Huefner, J. Nucl. Phys.; B47: No. 1, 205-39(1972).

The level shifts caused by the electromagnetic polarizability of the nucleus (N) and the orbiting particle (H) are investigated in detail. The static E1 polarizability strongly dominates in levels with $l \geq 4$ and the shift is $\Delta\epsilon = -\frac{1}{2}e^2(\alpha^N + Z^2\alpha^H)\,(r^{-4})_{n_0l_0}$. The polarizabilities of other multipoles are calculated with the help of sum rules. The polarization of the electron cloud is a small modification of electron screening. The quasistatic approximation for the particle in the atomic orbit is justified by deriving a number of exact expressions for averages of excitation energies and their spread. Numerical estimates of the effects of nuclear polarizabilities are given for various exotic atoms throughout the periodic system. The polarizabilities of π^-, K^-, $\bar{p}$ contribute a significant fraction to the total shift indicating the possibility of obtaining experimental information on hadron polarizabilities. (auth)

59826 EFFECT OF STRONG INTERACTIONS ON VACUUM POLARIZATION. Polyakov, A. M. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 1, 24-34 (Jul 1972). (In Russian).

The hypothesis of asymptotic scale invariance of strong interactions is applied in an analysis of radiative corrections to hadron amplitudes. It is shown that the corrections contain logarithmic divergences analogous to those in quantum electrodynamics. A method for summation of the major logarithmic terms in the radiative corrections to the strong interaction is proposed. It is shown that in the logarithmic approximation the corrections to the polarization operator cancel out in all orders of perturbation theory. As a result the physical electron charge can be expressed in terms of the electron bare charge, cut-off radius, and cross section for e^+e^- annihilation into hadrons. (auth)

59827 $\bar{p}n$ BOUND STATE AND THE MASS OF THE NUCLEON QUARK. MacGregor, M. H. (Univ. of California, Livermore). Lett. Nuovo Cim.; 5: No. 2, 135-8(9 Sep 1972).

It is pointed out that a well-known inconsistency is removed from the quark model by divorcing the mass of the quark from its nonobservability. Several arguments then place the mass of the nucleon quark at about 330 MeV. This gives a nucleon binding energy of about 5%, which is comparable to the measured $\bar{p}n$ binding energy of 4.4%. The mass of the $\bar{p}n$ bound state is quantitatively related to that of the nucleon. (L.B.S.)

59828 REGGE ANALYSIS AND DUAL ABSORPTIVE MODEL. Contogouris, A. P. (McGill Univ., Montreal). Springer Tracts Mod. Phys.; 63: 145-62(1972).

From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

A brief review is given of the weak cut model together with some of its most serious difficulties. The strong cut Reggeized absorption model and some of its failures are then discussed. The dual absorptive model is presented. A Regge pole-Regge cut analysis of certain important quasi-elastic reactions is discussed and it is shown how the dual absorptive model can be used in detailed calculations. The reactions $\pi^+n \rightarrow \omega^0p$, $\pi^+p \rightarrow \omega^0\Delta^{++}$, and $\gamma p \rightarrow \pi^+n$ and the cross section difference for $\gamma p \rightarrow \pi^+n$ and $\gamma n \rightarrow \pi^-p$ are considered. (L.B.S.)

59829 QUARK DIAGRAMS IN HIGH-ENERGY FORWARD, BACKWARD, AND LARGE-ANGLE SCATTERING. Dias de Deus, J. (Inst. de Physique Nucleaire, Paris). Lett. Nuovo Cim.; 5: No. 3, 269-75(16 Sep 1972).

The Chan–Paton approach is generalized to include baryons for the construction of dual quark models. The underlying structure of the two-body amplitudes of strong interactions is given by the quark diagrams. The possibilities of using spinless quark model diagrams to derive relations among cross sections for forward, backward, and large-angle scattering are illustrated. (J.F.P.)

59830 "WRONG" STATISTICS AND HADRON STRUCTURE. Krolikowski, W. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 20: No. 6, 487-94(1972).

A model of hadrons which provides the Bose statistics for $SU(6) \times 0(3)_L$ degrees of freedom inside baryons, not spoiling at the same time the Fermi statistics for whole baryons, leads to the $\Delta I = \frac{1}{2}$ rule for nonleptonic decays of hadrons, and introduces into nucleons some neutral partons in proportion consistent with deep inelastic scattering is proposed. This model is obtained if nine Fermi quarks of the three-triplet model, q_{aA} ($a = 1, 2, 3$ is the SU(3) triplet index and $A = 1, 2, 3$ is another three-value index) are replaced by bound states q_ac_A, where q_a ($a = 1, 2, 3$) are Bose quarks (Bose spin $\frac{1}{2}$ particles forming an SU(3) triplet) and c_A ($A = 1, 2, 3$) are Fermi spin 0 neutral particles called co-quarks. The nonexotic baryons and mesons are qcqcqc and qcqc bound states, respectively. Consequences and possible physical meaning of "wrong" statistics are briefly discussed. (auth)

59831 FERMION–MESON VERTICES IN DUAL THEORIES. Corrigan, E. (Oxford Univ.); Olive, D. Nuovo Cim.; 11A: No. 3, 749-73(1 Oct 1972).

The general dual vertex describing the transition of a Ramond fermion into a Neveu–Schwarz meson by the emission of a general excited fermion state is constructed. The vertex thus generalizes the previous results of Thorn and Schwarz and is now put into a relatively compact and manageable form in order to check that certain of the general gauge conditions are correctly converted between the meson and fermion legs by the vertex. The particular construction of the vertex can be applied to the other older dual theories and leads to some new insights into them. (auth)

59832 MODEL OF DIFFRACTIVE PRODUCTION IN HADRON–HADRON COLLISIONS. Bialas, A. (Jagellonian Univ., Krakow);

Czyz, W.; Kotanski, A. Ann. Phys. (N. Y.); 73: No. 2, 439-60 (Oct 1972).

A model for diffractive production off hadronic and nuclear targets is proposed. This model is a development of the Good and Walker description of such processes, and is also analogous to the model of Cheng and Wu for high-energy quantum-electrodynamical processes. The diffractive production process consists here of two steps: the incident particle fluctuates and it interacts elastically with the target either before or after the fluctuation. The vector dominance model of rho photoproduction and the Drell–Hiida-type models of diffractive production are special cases of the model proposed. Results of numerical calculations for the diffractive pion production in nucleon–nucleon collisions are discussed for the cases of some simple fluctuations. A fair agreement with the existing data for this process is found. (5 figures, 2 tables) (auth)

59833 POSSIBLE RENORMALIZATION OF THE NONLINEAR σ-MODEL. Bergere, M. C.; Drouffe, J. M. (CEN de Saclay, Gif-sur-Yvette, France). Nuovo Cim.; 11A: No. 1, 121-38(1 Sep 1972).

A natural way to determine the renormalization constants of the nonlinear σ model with only one extra parameter is presented; PCAC relations are fulfilled at all orders. This method is explicitly developed for one-loop graphs involving nucleons. (3 figures) (auth)

59834 LIGHT-CONE BEHAVIOR IN THE RELATIVISTIC QUARK OSCILLATOR MODEL. Montvay, I. (CERN, Geneva). Nuovo Cim.; 11A: No. 1, 207-21(1 Sep 1972).

The light-cone expansion of the commutators of bilocal currents is investigated in the relativistic oscillator quark model proposed by Feynman, Kislinger, and Ravndal. An infinite-component field theory formalism describing the oscillator bound states of quarks is introduced in order to define the current operators. The calculation of the light-cone expansions of current commutators shows that the elastic binding force, acting between the quarks, does not affect the light-cone behavior, which remains the same as in the free-quark model. The explicit forms of the deep inelastic structure functions W_1, W_2 are also calculated in the free infinite-component field theory model with an arbitrary number N of oscillating quarks ($N = 2$: mesons, $N = 3$: baryons, $N > 3$: exotics). The scaling limits of the structure functions are sums of δ-function terms coming from the individual quarks even if the instability of excited states is taken into account by giving the trajectory an imaginary part. This result indicates that nontrivial scaling functions are possible only in a model which accounts better for strong interactions. (auth)

59835 QUARK-LOOP DYNAMICS AND MESON DECAYS. Suura, H. (DESY, Hamburg); Young, Bing-lin. Nuovo Cim.; 11A: No. 1, 101-20(1 Sep 1972).

The effective quark mass and the meson–quark–quark coupling constants for three types of quark models are determined from a set of lowest-order quark-loop diagrams for static mesic amplitudes involving vector and axial vector vertices. These parameters are applied to evaluate certain mesic decays and the SU_3 mass splitting of the 0^- octet and 1^- nonet, which serve as tests for the quark models. Adler's low-energy theorem for the $\pi^0 \rightarrow 2\gamma$ decay is derived in this approach without invoking the Adler–Schwinger anomaly. The test favors the Nambu–Han model of integrally charged quarks. Critical examinations of the underlying assumption of the quark-loop dominance are made, and a speculation on a physical model which allows such a situation is proposed. (3 figures, 1 table) (auth)

59836 MULTIPARTICLE PRODUCTION IN HIGH ENERGY PARTICLE COLLISIONS. Shuryak, E. V. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz.; 16: No. 2, 395-405(Aug 1972). (In Russian).

Multiparticle production in collision of a hadron pair was considered. Thermodynamic characteristics of an excited substance were obtained, taking into account the strong interaction. The process of secondary divergence is studied with the help of relativistic hydrodynamics. The obtained momentum spectra of secondaries are in a good accord with the data on π, K, $\bar{p}$ production in the energy range of initial particles 10 to 70 GeV. (auth)

59837 UNITARITY AND THE REGGE EIKONAL MODEL. Weare, T. J. (Oxford Univ.). Nuovo Cim.; 11A: No. 1, 77-86(1 Sep 1972).

An approximate unitarity sum rule derived by Sawada is applied to the Regge eikonal model and, in particular, it is found that the usual moving pomeron trajectory is forbidden in this model. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 59711 and 60034.

59838 (DESY–72/47) LONG RANGE POTENTIAL MODEL OF HADRONS. Suura, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Aug 1972. 12p. Dep. NTIS (U. S. Sales Only).

A hadron model is proposed in which nonasymptotic quarks interact with a coherent and long-range vector gluon field, with a resulting linearly rising spectrum. Solutions for $L = 0$ pseudoscalar and vector mesons in this model exhibit a SU_6 type structure. The pion decay constant and the $\rho-\gamma$ coupling constant for the unperturbed ground states satisfy the KSRF relation and have the right order of magnitude. The ratio $\sigma(e^+ + e^- \rightarrow \text{vector mesons})/\sigma(e^+ + e^- \rightarrow \mu^+ + \mu^-)$ decreases like $S^{-1/2}$ in the present model, whereas it is shown that the ratio approaches a constant in the 3-dimensional oscillator potential model. (auth)

59839 SOLUBLE REALISTIC MODEL FOR $I = 0$ AND $I = 1$ ππ SCATTERING. Johannesson, N.; Shirkov, D. (Univ. of Lund, Sweden). Nucl. Phys.; B47: No. 1, 189-99(1972).

Using the small $I = 2$ s-wave as an input a soluble set of equations for $I = l = 0$ and $I = l = 1$ partial waves of low-energy pion–pion scattering is obtained. The simplest solution depends only on 2 arbitrary constants which is fixed with the aid of PCAC threshold predictions. The obtained solution shows that the account of a small negative Re A_2 improves the result obtained earlier. The δ_1^1 and δ_0^0 phase-shifts become more close to the experimental values. The typical figures are now $m_\rho \sim 750 - 800$, $\Gamma_\rho \sim 200 - 230$ and $\delta_0^0(m_p) \sim 60 - 70°$ instead of $m_\rho \approx 940$, $\Gamma_\rho \approx 260$ $\delta_0^0(m_\rho) \approx 45°$ obtained earlier. The δ_0^0 energy behavior is close to the "down–down" experimental solution from the analysis of $\pi N \rightarrow \pi\pi N$ and does not pass through a resonance, but rather has a wide maximum at $W \sim 1$ GeV. (auth)

59840 DETERMINATION OF X^0(960)-MESON SPIN–PARITY IN PROTON–ANTIPROTON ANNIHILATION AT REST. Genina, L. E.; Zaslavskii, A. N.; Lednitski, R. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 5, 1028-31(May 1972). (In Russian).

A method was proposed for determining X^0 (960)-meson spin-parity in $p\bar{p}$-annihilation at rest. The angular correlations which permit one to distinguish two equally probable at present time hypotheses: $J^P(X^0) = 2^-$ and $J^P(X^0) = 0^-$ are obtained. (auth)

59841 PARTIAL ANALYSIS OF NN- AND N$\bar{N}$-SCATTERING AMPLITUDES AT HIGH ENERGY. Kuznetsov, G. I. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 15: No. 5, 1035-46(May 1972). (In Russian).

The spin structure of the NN- and N$\bar{N}$-scattering amplitudes is considered. A Regge pole classification is given, and their contribution to various partial s- and t-channel amplitudes is investigated. The s- and t-channel amplitudes are further expanded in Lorentz group representations and integral relations between relativistic partial s- and t-channel amplitudes are deduced. (autu)

59842 CLASS OF ANALYTIC INTERFERENCE MODELS. Donnelly, M. G.; Kreps, R. E. (Univ. of Toronto). Phys. Rev., D; 6: No. 7, 2009-14(1 Oct 1972).

A class of interference models is presented with good analytic properties, arbitrary trajectory functions, no ancestors or ghosts, and a fair amount of freedom remaining. Asymptotics are good for bounded trajectories; for linearly rising trajectories there is trouble in one direction. As an example a small calculation is done on $X^0 \rightarrow \eta\pi\pi$. (auth)

59843 DUALITY AND MASS QUANTIZATION. Krolikowski, W. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 20: No. 6, 495-501(1972).

The correspondence principle proposed by Ramond is extended in such a way as to include the leading meson mass. Then one gets a full mass quantization for mesons in terms of three universal constants: ħ, c and the Regge trajectory slope a′. In particular, it follows that $m_\pi^2 = 0$ and $m_\rho^2 = 1/2$ in the units where $\hbar = c = a' = 1$. The SU(1,1) generators are constructed from "internal" fields in the cases of Bose and Fermi mass quantizations. However, the other Virasoro generators are constructed in the Fermi case only, and not to be found in the Bose case. This may reflect a close relation between "internal" statistics and the SU(1,1) spin in the dual theory, reminding one of the Pauli theorem. (auth)

59844 POWER SPECTRUM OF THE NEUTRINO SEA. Ruderfer, M. (Dimensions, Inc., Hempstead, N. Y.). Lett. Nuovo Cim.; 5: No. 1, 86-8(2 Sep 1972).

It argued that for a gas of unbound neutrinos, it is more appropriate to abandon Fermi–Dirac statistics. The power spectrum of a sea of unbound neutrinos derived from Bose–Einstein statistics is examined. (L.B.S.)

59845 COHERENT PHOTOPRODUCTION OF HEAVY NEUTRAL MESONS ON SPIN-0 NUCLEI. Adamovich, M. I.; Lebedev, A. I. (Lebedev Physics Inst., Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 1, 32-4(5 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 1, 47-9(5 Jul 1972).

The possibility of determining the spins of the neutral mesons by studying the reactions of their coherent photoproduction on ^{4}He is discussed. The lower multipole transitions of this reaction and the corresponding angular distributions of the mesons in the cms are listed, and the form of the differential cross section of this reaction is found. From this information the spin of the neutral mesons is obtained. The cross sections for the photoproduction of X^0 and η can be estimated using the same relations. (J.F.P.)

59846 DIFFRACTION PRODUCTION OF A_1 MESON. Kafiev, Yu. N.; Serebryakov, V. V. (Inst. of Mathematics, Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.); 16: No. 1, 37-9(5 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 1, 54-7(5 Jul 1972).

The diffraction-dissociation cross section for the reactions $\pi^+ + p \rightarrow A_1^+ + p$ and $\pi^- + p \rightarrow A_1^- + p$ at medium energies is considered. The effective slope of the differential cross section of A_1 production is found to be 19 GeV at $t \leq 0.05$. (J.F.P.)

59847 CONNECTION BETWEEN THE INTERACTION TOTAL CROSS SECTION AND THE SLOPE OF DIFFRACTION CONE. Kaidalov, A. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 16: No. 2, 389-94(Aug 1972). (In Russian).

It was exhibited that all the available experimental data on the total cross sections $\sigma^{tot}(s)$ for $\pi^{\pm}p$-, $K^{\pm}p$-, pp- and $\bar{p}p$-interactions at $p_{lab} > 2$ GeV/c as well as those for the slopes of diffraction cones $\Lambda(s)$ in the corresponding processes of elastic scattering satisfy the ratio $(2p/\sqrt{s})\,[\sigma^{tot}(s)/\Lambda(s)]\,C(s) = 4\pi$, where $C(s) = 1 + [\sigma_{in}^{P}(s)]/[\sigma_{el}^{P}(s)]$ and $\sigma_{el}^{P}(s)$ and $\sigma_{in}^{P}(s)$ are contributions of the vacuum singularity to the cross section of elastic and inelastic processes. Theoretical interpretation of this ratio is given in the framework of the complex moment theory, that takes into account Regge poles as well as moving branchings in the j-plane. (auth)

Strong (Baryon No. = 1)

59848 (JINR–E1-6745) AVERAGE QUANTUM NUMBER PER PARTICLE. WHAT ARE THEY GOOD FOR? Mihul, A.; Besliu, T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1972. 12p. Dep. NTIS (U. S. Sales Only).

The average per particle of the baryon, electric and strange quantum numbers is used for approximate analysis of the leading properties of the incident particles. A similar shape of the average baryon quantum number distribution as a function of $x = P_L/P_{L.max}$ is found for πp and pp inclusive reactions between 6 and 1500 GeV/c (laboratory momentum). (auth)

59849 ISOSPIN ANALYSIS OF THE REACTIONS $K^-p \rightarrow \bar{K}\pi N$ AND $K^-p \rightarrow \bar{K}^*$ (890)πN AT 10 GeV/c. Aachen-Berlin-CERN-London(I.C)-Vienna Collaboration. Nucl. Phys.; B47: No. 1, 43-50(1972).

An analysis was made of the reaction $K^-p \rightarrow \bar{K}(\pi N)$ in terms of the isospins of the t-channel $(K^- \rightarrow \bar{K})$ exchange and of the (πN)-system. It is found that the dominant process is isoscalar exchange, which is identified with the diffractive dissociation of the proton. The (πN) mass spectrum corresponding to this process presents an asymmetric enhancement of very large width peaked at about 1.3 GeV, well below the mass of any established N* isobar. The $d\sigma/dt$ distribution is well-fitted in the t-range 0.0–0.2 GeV^2 by an exponential with slope parameter ≈ 7 GeV^{-2}, the same as for elastic K^-p scattering at the same energy. The diffractive $K^-p \rightarrow K^-(\pi N)^+$ cross section is found to be (10 ± 2)% of the elastic K^-p cross section, which is equal to the corresponding ratio found for πp interactions at 16 GeV/c. A similar isospin analysis of the reactions $K^-p \rightarrow \bar{K}^*(890)\,(\pi N)$ reveals an isoscalar exchange cross section in this case smaller than that for isovector exchange. (auth)

59850 RADIATIVE PION CAPTURE BY HYDROGEN AND SIGN OF NEUTRAL PION DECAY AMPLITUDE. Lapidus, L. I.; Musakhanov, M. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 5, 1002-8(May 1972). (In Russian).

The expressions were obtained for the amplitude of pion capture at rest by protons with a two photon production, for the neutron spectrum, and γ-quantum angular correlations. It is shown that the investigation of the process under discussion in the neutron energy region near 420 keV will permit one to determine sign of the two photon pion decay amplitude. (auth)

59851 INVARIANT AMPLITUDES FOR πN CHARGE-EXCHANGE FORWARD SCATTERING. Dronkers, J. (CEN, Saclay, France); Kroll, P. Nucl. Phys.; B47: No. 1, 291-300(1972).

The isospin-odd invariant amplitudes at $t = 0$ are studied using the latest experimental data and dispersion relations. The amplitude $B^{(-)}$ and the derivative $(\partial/\partial t)\ln|A'^{(-)}|$ are determined in the energy range from 2 to 14 GeV. For energies larger than 6 GeV the agreement with the energy dependence of a σ Regge-pole model is very good. (auth)

59852 ELIMINATION OF PARITY DOUBLETS. Storrow, J. K. (Daresbury Nuclear Physics Lab., Eng.). Nucl. Phys.; B47: No. 1, 174-88(1972).

In the theory of Reggeized baryon exchange with linear trajectories residue functions which eliminate all parity doublets are constructed. The simplest such residue function is shown to be unsatisfactory and modifications are given and discussed. (auth)

59853 INCLUSIVE SINGLE PARTICLE SPECTRA FOR CHARGE EXCHANGE REACTIONS AND THE MULTI-REGGE MODEL. Blutner, R.; Ranft, Gisela (Karl-Marx Univ., Leipzig). Nucl. Phys.; B47: No. 1, 240-8(1972).

From the multi-Regge model the momentum spectrum of K^0 in the reaction $K^+p \rightarrow K^0$ + anything is computed. The calculation is performed without any approximation in the kinematics for the fragmentation as well as the pionization graph. Only the ratio between the single and the double peripheral graph is treated as a free parameter. Good agreement with the data at 8.2 GeV/c is obtained. From this model the neutron spectrum in proton proton collisions, pp → n + anything is predicted. (auth)

59854 SHORT RANGE πN P-WAVE INTERACTIONS. COMPARISON WITH HIGH-ENERGY BACKWARD REGGE MODELS. Elvekjaer, F. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys.; B47: No. 1, 253-68(1972).

Using the nonreduced discrepancies the P-wave forces are broken up into long-range parts and short-range parts. The long-range t-channel forces of the nonreduced P-waves are shown to be adequately described by ρ- and σ-exchange. The short-range parts are related to high energy backward scattering. The comparison with the usual Regge model shows a large inconsistency in the isospin ½ amplitudes. The implications of this inconsistency are discussed in connection with the recent high energy data on πN backward scattering. (auth)

59855 SIMPLIFIED REGGE ANALYSIS OF BACKWARD π^+p SCATTERING. Kogitz, S.; Logan, R. K. (Univ. of Toronto). Phys. Rev., D; 6: No. 7, 2028-32(1 Oct 1972).

Polarization and differential-cross-section data for backward π^+p scattering are explained in terms of a model which includes the N_α Regge pole plus a background term which one may interpret as either a secondary pole or cut. This model, although simplifying the number of exchanges, provides an excellent fit to the data. The dip-bump structure and polarization are related. The rise of the differential cross section after the dip is shown in this model to be due in part to the background term rather than solely the recovery of the N_α Regge-pole term from zero due to the vanishing of $\alpha - ½$ near $u = -0.14$ (GeV/c^2). (auth)

59856 APPLICATION OF A NEW KINEMATIC VARIABLE TO INELASTIC TWO-BODY REACTIONS. Maor, Uri (Tel-Aviv Univ., Israel). Phys. Rev., D; 6: No. 7, 2052-4(1 Oct 1972).

The relevance of a new kinematic variable, suggested recently, is reexamined through the analysis of π^-p charge-exchange reactions. It is found that the suggested parametrization, with a fixed crossed-channel pole, reproduces well the forward differential cross sections. However, the new description does not provide a satisfactory interpretation of the π^-p charge-exchange dips, and additional theoretical input is required. (auth)

59857 ESTIMATE OF $\pi^-p \rightarrow \pi^0n$ AMPLITUDES IN TERMS OF DIRECT-CHANNEL RESONANCES AND DUAL-ABSORPTIVE REQUIREMENTS. Argyres, Ernestos N. (State University Coll. of Arts and Science, Plattsburgh, N. Y.); Contogouris, A. P. Phys. Rev., D; 6: No. 7, 2018-23(1 Oct 1972).

The real parts of the s-channel helicity amplitudes, the differential cross section, and the polarization for $\pi^-p \rightarrow \pi^0n$ are estimated at $t = -0.175$ and -0.5 GeV^2 by means of dispersion relations, s-channel resonances, and dual absorptive requirements. The results are in satisfactory agreement with experiment and with recent amplitude analysis. (auth)

59858 OCTET POMERANCHUKON COMPONENT AND ABSORPTION IN HYPERCHARGE-EXCHANGE REACTIONS. O'Donovan, P. J.; Prickett, T. E. (Arizona State Univ., Tempe). Phys. Rev., D; 6: No. 7, 1995-9(1 Oct 1972).

General features of absorption are used to derive simple relations for hypercharge-exchange differential cross sections at small t, with the Pomeranchukon permitted to have an octet as well as a singlet part. The data for these reactions are then used to extract, as a function of s and t, the ratio of the octet absorption term to the sum of the Regge-pole and singlet absorption terms. Four independent determinations yield a unique ratio which is essentially independent of s and exhibits a very slow t variation. It is noted that these features, as well as the sign and magnitude of the ratio, are in excellent agreement with f-dominated Pomeranchukon predictions. (auth)

59859 STUDY OF VECTOR-MESON PRODUCTION WITH HYPERCHARGE EXCHANGE. Field, R. D.; Eisner, R. L.; Aguilar-Benitez, M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 6: No. 7, 1863-82(1 Oct 1972).

Results are presented on the joint density-matrix elements for $K^-p \rightarrow (\omega,\phi)\Lambda$ and are compared with the newly obtained values for $\pi^-p \rightarrow K^{*0}\Lambda$. The joint density-matrix elements are used together with the polarization to isolate various interferences between amplitudes with definite t-channel quantum numbers. Large interferences are found between natural-parity amplitudes (K^{**},K^*) and sizeable interferences between unnatural-parity amplitudes (K,K_A) are found. A five-effective-pole (K^{**},K^*,K,K_B,K_A) fit with SU(3) to the eight reactions $K^-p \rightarrow (\rho,\omega,\phi)\ (\Lambda,\Sigma^0)$ and $\pi^-p \rightarrow K^{*0}(\Lambda,\Sigma^0)$ is presented. The solution gives a good fit to the data for all eight reactions including the joint density-matrix elements. The values of F/D determined from this fit are consistent with values determined in other analyses. Quite apart from the details of any exchange model the data on vector-meson production with hypercharge exchange are found to be in good agreement with quark-model predictions. (auth)

59860 FLUCTUATIONS, DIPS, AND DUALITY. Henzi, R.; Margolis, B.; Ross, W. A. (McGill Univ., Montreal). Phys. Rev., D; 6: No. 7, 1916-18(1 Oct 1972).

Data for backward elastic scattering of pions by protons are examined. The width and frequency of the dips seen, as a function of energy, are strongly suggestive of Ericson fluctuations. The implications of this observation are discussed. (auth)

59861 EMPIRICAL SYSTEMATICS OF πN AMPLITUDES. Barger, V.; Halzen, F. (Univ. of Wisconsin, Madison). Phys. Rev., D; 6: No. 7, 1918-26(1 Oct 1972).

The structure of πN s-channel helicity amplitudes as a function of momentum transfer and energy is examined in FESR (finite-energy sum rule) Regge fits, direct amplitude analysis of data, and phase-shift analyses. Information on the separated amplitudes from these various sources is found to agree. The value of helicity correlation measurements in testing the zero structure of helicity amplitudes is demonstrated. The approximation of s-channel helicity conservation for the $I_t = 0$ amplitude above 5 GeV/c is justified from polarization data. The partial-wave and impact-parameter decompositions of the FESR Regge results are presented. (auth)

59862 LOW ENERGY THEOREMS AND PHOTO- AND ELECTROPRODUCTION NEAR THRESHOLD BY CURRENT ALGEBRA. Furlan, G.; Paver, N.; Verzegnassi, C. (Univ., Trieste, Italy). Springer Tracts Mod. Phys.; 62: 118-47(1972).

From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

A simple formalism, based on current commutators, to obtain a representation of physical pion amplitude is illustrated, where both the soft pion limit and the corrections are explicitly exhibited. The main features of the formalism are reviewed and applied to pion—nucleon scattering at threshold. As a further example, the electroproduction and photoproduction of a single pion are treated. (L.B.S.)

59863 EIKONAL MODEL FOR REGGE CUTS IN PION-NUCLEON SCATTERING. Collins, P. D. B.; Gault, F. D. Springer Tracts Mod. Phys.; 63: 163-89(1972).

From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

Some recent progress made in the use of the eikonal model in perturbation theory is reviewed and it is shown how the model can plausibly be generalized to include any number of different types of Regge exchanges, and how the conventional absorption model is obtained as an approximation. It is also demonstrated that the over-absorption problems of the strong-cut model are automatically cured when the full set of Regge cuts is included. Different versions of the eikonal model are tested against the πN elastic and charge-exchange scattering data. (L.B.S.)

59864 VENEZIANO MODEL WITH CUTS FOR $\bar{K}$N AND KN CHARGE-EXCHANGE SCATTERING. Adjei, S. A. (Imperial Coll. of Science and Tech., London); Collins, P. A.; Hartley, B. J.; Moore, R. W.; Moriarty, K. J. M. J. Phys., A (London); 5: No. 5, 736-44(May 1972).

A Veneziano model, which agrees to leading order in s with the Reggeized U(6,6) model, is applied to $\bar{K}$N and KN charge-exchange scattering. Leading order "duality-preserving" cuts are introduced and an improved agreement with low energy $K^+n \rightarrow K^0p$ data is obtained. (auth)

59865 OPTIMAL EXTRAPOLATION OF PION–NUCLEON SCATTERING: THE σ TERM RE-EXAMINED. Shih, C. C. (Univ. of Tennessee, Knoxville); Shepard, H. K. Phys. Lett.; 41B: No. 3, 321-4(2 Oct 1972).

By using a new technique of analytic extrapolation $A^{(+)}_{\pi N}$ was determined at $s = u = M^2$ and, for the first time, a realistic estimate of the extrapolation error was made. The value $A^{(+)} = 189 \pm 14$ GeV^{-1} implies $\sigma^{NN} = -46 \pm 140$ MeV. (auth)

59866 MULTIPLE SCATTERING MODEL FOR PION–NUCLEON SCATTERING AND THE SLOPE OF THE POMERANCHUK TRAJECTORY. Fincham, D. (Univ. of Aberdeen, Eng.). J. Phys., A (London); 5: No. 6, 838-52(Jun 1972).

The multiple scattering model of Frautschi and Margolis (1968), with secondary trajectories included, is applied to pion-nuclear elastic and charge-exchange scattering. It is possible to explain the Serpukhov high energy total cross section data, but no other data such as the phase of the forward amplitude and the elastic scattering polarization. (auth)

59867 LOW-ENERGY THEOREMS FOR MASSIVE VECTOR MESONS. Fiorentini, G. (Scuola Normale Superiore, Pisa, Italy). Lett. Nuovo Cim.; 5: No. 3, 276-80(16 Sep 1972).

It is shown that in a general quantum field theory in which I-spin currents are defined simple assumptions about the Schwinger terms in current—current commutators lead directly to the low energy theorems. The interaction of an I-spin triplet of massive vector mesons (ρ) with nucleons (N) and pions (π) is studied. From the analysis of the 3-point function the universality of the ρ coupling constant at zero momentum is obtained. The nonperturbative result that all the coupling constants are equal when the four-momentum of a vector meson is zero is found. (J.F.P.)

59868 PARTICLE PRODUCTION SPECTRA AND THE INTERNAL STRUCTURE OF THE HADRONS. Wang, C. P. (Cambridge Univ., Eng.); Lin, A. L. L. J. Phys., A (London); 5: No. 9, 1374-83(Sep 1972).

Longitudinal momentum distributions of produced pions from hadron-hadron collisions were derived from the quark-boson hadron model in which the hadron is a bound system of quarks (three for a nucleon, two for a meson) and a number of fluctuating charged and neutral bosons. The model was obtained previously from the study of the inelastic form factors, or the structure functions, in eN, νN, and $\bar{\nu}$N scattering. The momentum distributions derived with no free parameter fit through the five-decade measured cross sections for pp interactions and reproduce the asymmetric spectra observed in π^-p, π^+p and K^+p interactions. (auth)

59869 VENEZIANO MODEL, WITH ABSORPTIVE CORRECTIONS, FOR HIGHER SPIN PRODUCTION. Collins, P. A.; Hartley, B. J.; Moore, R. W.; Moriarty, K. J. M.; Parry, G. W. (Imperial Coll. of Science and Tech., London). J. Phys., A (London); 5: No. 5 726-35(May 1972).

A Veneziano model is applied to higher spin production processes in the near forward scattering region over an extended energy range, for the processes $K^+p \rightarrow K^0\Delta^{++}$ and $K^+p \rightarrow K^{*+}p$. Absorption corrections are included to take some account of unitarity, and the U(6,6) symmetry scheme is used to determine the coupling constants. While the results for $K^{*+}p$ are an improvement on previous Regge calculations, the results for $K^0\Delta^{++}$ are similar and suffer from the fact that the $\bar{N}\Delta$ coupling constant is too small. (auth)

59870 RADIAL EXCITATIONS IN THE SYMMETRIC QUARK MODEL. Kim, Y. S. (Univ. of Maryland, College Park); Noz, M. E. Nuovo Cim.; 11A: No. 3, 513-22(1 Oct 1972).

Radial excitation modes are analyzed for nonstrange baryons. It is found that the baryon radial mode exhibits a harmonic-oscillatorlike mass spectrum with the energy spacing of 270 MeV.

It is shown that a large SU_6 force is responsible for this narrow spacing. It is shown also that this SU_6 force is responsible for the exceptionally low mass of the Roper resonance. (auth)

59871 ANALYSIS OF $\pi^- p \rightarrow \pi^- \pi^+ n$ DATA AT 17.2 GeV/c. Estabrooks, P.; Martin, A. D. (CERN, Geneva). Phys. Lett.; 41B: No. 3, 350-4(2 Oct 1972).

An amplitude analysis for $\pi^- p \rightarrow \pi^- \pi^+ n$ data is proposed which allows for the possibility of A_2 exchange as well as absorbed pion exchange in a model-independent way. This leads to an improved extrapolation method for extracting $\pi\pi$ phase shifts. By using the recent CERN–Munich data at 17.2 GeV/c, the π and A_2 exchange contributions are isolated and the form of the absorptive corrections is determined. No evidence for an exchange contribution with the quantum numbers of the A_1 is found. (auth)

59872 REGGE CUTS AND MULTIPLE REGGE-POLE EXCHANGE IN INVARIANT FUNCTIONS. Geicke, J. (Freie Univ., Berlin). Nuovo Cim.; 11A: No. 3, 785-91(1 Oct 1972).

Following the ideas of the Regge eikonal model a relativistic Regge-cut model for invariant functions is proposed. Features of the model are discussed for πN charge-exchange scattering. (auth)

59873 CONSEQUENCE OF CROSSING SYMMETRY FOR MULTIPLE REGGE-POLE EXCHANGE IN PION–NUCLEON SCATTERING. Geicke, J. (Freie Univ., Berlin). Nuovo Cim.; 11A: No. 3, 792-7(1 Oct 1972).

From relations between crossing behavior and t-channel isospin of πN scattering amplitudes some information is obtained about the shape of eikonal amplitudes in this process. (auth)

59874 FOURIER–BESSEL TRANSFORMS OF HELICITY AMPLITUDES. Kamal, A. N. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 5: No. 1, 51-8(2 Sep 1972).

A method proposed for the construction of the Fourier–Bessel transforms of scattering amplitudes is applied to helicity amplitudes for πN and K^+p interactions. It is found as a result that the qualitative features of the helicity-nonflip (flip) amplitude are very similar to those of the spin-nonflip (flip) amplitude. (L.B.S.)

59875 EMPIRICAL SCALING BEHAVIOR OF HADRON–HADRON TOTAL CROSS-SECTIONS. Takagi, F. (Tohoku Univ., Sendai). Lett. Nuovo Cim.; 5: No. 1, 101-7(2 Sep 1972).

It is shown that diffractive and nondiffractive components of $\pi^\pm p$, $K^\pm p$, $\bar{p}p$ and pp total cross sections multiplied by $4k^2/S$ show a remarkable scaling behavior as functions of S or k^2, where S is the square of the total energy in the cm system and k^2 is the square of the relative three-momentum of the incident particle in the cm system. (L.B.S.)

59876 MASS FORMULA FOR RESONANCES WITH IDENTICAL STRANGENESS, PARITY, ORDINARY, AND ISOTOPIC SPIN. Kalman, C. S. (Loyola Coll., Montreal); Patera, J. Lett. Nuovo Cim.; 5: No. 1, 78-80(2 Sep 1972).

A mass formula is derived for resonances with identical quantum numbers under simple symmetry assumptions: U_1 as a symmetry group, $SU_{1,1}$ as a dynamical group. (L.B.S.)

59877 PHENOMENOLOGICAL STUDY OF HIGH-ENERGY EXCHANGES BASED ON MULTIPERIPHERAL IDEAS. Fontan, C. Ferro (CERN, Geneva); Masperi, L.; Page, R. Lett. Nuovo Cim.; 5: No. 1, 9-14(2 Sep 1972).

A phenomenological study is made of high-energy exchanges based on the following empirical observation: typical P′-pole parametrizations in the intermediate-energy range reproduce, in the global duality sense, the combinations of total elastic cross sections with the quantum numbers of the vacuum in the crossed channel. The total cross sections for πN, KN, and NN were fitted with a parametrization consisting of Regge poles P, ρ, and ω and several possible representations for P′. The rise of the K^+p total cross section is explained with a natural mechanism for the breaking of exchange degeneracy. (L.B.S.)

59878 TWO-PARTICLE CORRELATIONS IN INCLUSIVE REACTIONS. Berger, E. L. (Argonne National Lab., Ill.); Jacob, M. Phys. Rev., D; 6: No. 7, 1930-3(1 Oct 1972).

Two-particle inclusive distributions and correlation functions are computed from a model which emphasizes single production of resonance-like hadrons (novas) which cascade decay through pion emission. Strong positive correlations are predicted at small values of the center-of-mass rapidity of the final pions. The magnitude and energy dependence of $\langle n_{\pi^-} \rangle$ and $\langle n_{\pi^-}(n_{\pi^-} - 1) \rangle$ are reproduced correctly. Good agreement is obtained with experimental $d\sigma/dy$, $d^2\sigma/dy_1dy_2$, and $C(y_1, y_1)$ from the data on $\pi^+p \rightarrow \pi^-\pi^-X$ at 18.5 GeV c. (auth)

59879 ELECTROMAGNETIC CONTRIBUTIONS OF THE DIFFERENCE OF THE TOTAL CROSS SECTIONS FOR THE SCATTERING OF PARTICLES AND ANTIPARTICLES AT HIGH ENERGIES. Kondratyuk, L. A.; Kopeliovich, V. B. (Inst. of Nuclear Physics, Leningrad). JETP Lett. (USSR) (Engl. Transl.); 16: No. 3, 142-5(5 Aug 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 3, 201-4(5 Aug 1972).

The differences due to the interference between the electromagnetic and strong interactions at energies above 300 GeV between the total cross sections of charged particles and antiparticles are calculated. It is shown that the main contribution to the difference of the total cross sections of charged particles and antiparticles decreases logarithmically with increasing energy if the scattering cone narrows logarithmically. The scattering of $\pi^+ + p$ and $\pi^- + p$ is considered for concreteness. (J.F.P.)

59880 APPLICATION OF THE REGGE-POLE MODEL TO $\Delta(1236)$ PRODUCTION REACTIONS. de Brion, J. P.; Lewin, C. (CEN, Saclay, France). Nuovo Cim.; 11A: No. 1, 139-52(1 Sep 1972).

A lot of data have recently been published about the quasi-two-body channels $\pi^+p \rightarrow \pi^0\Delta^{++}(1236)$ and $\pi^-p \rightarrow \pi^-\Delta^+(1236)$ at high energies. By using a basic formulation of Renninger and Sarma modified by corrective terms depending on the ρ' pole, a Regge model is fitted to the data. A general fit with ten parameters exhibits very good agreement with experiments concerning the shapes and the energy dependence of the differential cross sections. In spite of important normalization problems arising in the second reaction, the results of both channels are compatible with the fit and no systematic discrepancies are observed. The dominance of M1 coupling at the $p\rho\Delta$ vertex is well verified at any t, except for the forward direction, where no experimental dips are observed, whereas the prediction is $d\sigma/dt = 0$ when $t = 0$. The secondary ρ' pole introduced into the B amplitude only (in the M1 dominance frame) improves the fit at lower momenta, in a way similar to that observed in the charge-exchange reaction. Concerning the density matrix elements, the ρ exchanged alone predicts curves on the boundary of the polarization domain; the experimental results at small transfer and high energies are inside this domain and show that (within statistics) more than one trajectory is needed. Nevertheless, the addition of the ρ' does not significantly modify the prediction given by the ρ alone, and relatively disagrees with experimental values at 8 and 11.6 GeV/c. (5 figures, 4 tables) (auth)

59881 SINGLE DISPERSION INTEGRALS FOR THE πN BOX DIAGRAM. Brunet, R. C. (Univ. of Montreal). pp 2.1-2.6 of Advanced Computing Methods in Theoretical Physics. Vol. 1. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655–(Vol.1).

An analytic calculation of the πN box diagram is presented. A simple expression over closed form elementary functions is given for the direct and crossed box diagram. The technique for performing other similar calculations where spin is involved is also illustrated. The methods used for checking the correctness of the results are emphasized. (France)

59882 ALGEBRAIC PROCEDURE FOR PROJECTION ONTO INVARIANT AMPLITUDES OF SCATTERING PROCESSES INVOLVING SPIN. Oberholzer, J. (Univ., Geneva). pp 2.43-2.57 of Advanced Computing Methods in Theoretical Physics. ol. 1. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655–(Vol.1).

The complications introduced into scattering processes by the presence of spinning particles are treated by decomposing the scattering amplitude into different invariant parts (the same number as the helicity amplitudes). The method is developed for the case of $\pi - N$ scattering. A general formalism incorporating a method of calculating specific traces is used to construct projection operators onto the invariant amplitudes of the $\pi - N$ scattering; the explicit perturbation contributions to the invariant amplitudes are determined. The method is then adapted to $N - N$ and $e - \mu$ scattering; its generalization to Compton scattering problems is envisaged. (France)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 60245 and 60255.

59883 (JINR–E2-6652) PIONIZATION AT ISR-ENERGIES. Jabs, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab.

of Theoretical Physics). 1972. 22p. Dep. NTIS (U. S. Sales Only).

It is shown that the same formula that describes pionization in multiple particle production at accelerator energies, up to 30 GeV, can also describe inclusive single-particle production spectra obtained at the CERN Intersecting Storage Rings, corresponding to an energy of 1000 GeV. By determining the parameters of the pionization formula at ISR energies one can draw some conclusions about the pionization process at high energies and about some gross features of multiple particle production. (auth)

59884 pp SLOPE BREAK AND THE POMERON PERIPHERY. Barger, V. (Rutherford Lab., Chilton, Eng.); Phillips, R. J. N.; Geer, K. Nucl. Phys.; B47: No. 1, 29-35(1972).

It is shown that a peripheral component of the pomeron, with radius 1.2 fm, gives a quantitative explanation of the break at $t = -0.1$ found in the pp elastic slope parameter b(pp) in ISR experiments. The energy-dependence of b(pp) above 200 GeV is accounted for by a pomeron trajectory with slope $\alpha'_p \approx 0.2$. The effects of f^0,ω exchanges are significant in b(pp) up through ISR energies. A simple explicit model that fits pp and $\bar{p}p\sigma_T$ and $d\sigma/dt$ data above 20 GeV and accounts for the $\Delta b(pp) \approx 1.5$ rule of the pp slope break at all energies is constructed. (auth)

59885 PION-DEUTERON SCATTERING LENGTH. Kolyubasov, V. M.; Kudryavtsev, A. E. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 1, 35-47(Jul 1972). (In Russian).

By summation of an infinite series of nonrelativistic Feynman diagrams a formula is obtained for the π-meson—deuteron scattering length which is a generalization of the Brueckner formula. It is then demonstrated that allowance for terms corresponding to the kinetic energy of nucleons in the intermediate state significantly changes the Brueckner result. The effect of p-wave πN interaction in diagrams with single or double scattering are estimated. The general relations obtained are applied to a numerical calculation of the πd scattering length. For this purpose the πN scattering lengths presented in survey and the Hulthen wave function for the deuteron are employed. The result is $a_{\pi d} = -0.047$ f. (auth)

59886 ONE-BOSON-EXCHANGE POTENTIAL MODEL FOR THE Λp INTERACTION. II. Brown, J. T. (Colorado School of Mines, Golden); Downs, B. W.; Iddings, C. K. Nuclear Phys.; B47: No. 1, 138-56(1972).

A one-boson-exchange potential model for the Λp interaction, which includes the ΣN channel explicitly is described. This model is an extension of a model previously discussed. The extension consists of the addition of a unitary singlet pseudoscalar meson (χ^0) and an octet of scalar bosons. This extension enables one to fit the experimental low-energy Λp data with values of some meson-baryon couplings closer to generally preferred values than was possible with the previous model. In particular, the coupling of the unitary singlet vector meson (ω) to baryons is $g^2_\omega/4\pi = 4.5$ in this model, whereas it was 24.9 in the earlier model. The present model contains the effects of nonets of pseudoscalar, vector and scalar bosons. The parameters of the model are boson and baryon masses, the couplings of the bosons to baryons and a spin-independent, channel-independent hard-core radius. SU(3) was used to relate the couplings. Four parameters of the model were adjusted to reproduce the most recent low-energy Λp data; all other parameters were fixed beforehand from other considerations. The adjusted parameters are the hard-core radius, the mass and coupling of a unitary singlet scalar boson, and the coupling of the neutral isospin-one member of the octet of scalar bosons to protons. The model provides a very good fit to the experimental Λp cross section data up to and above the ΣN threshold. The $({}^3S_1-{}^3D_1)$ partial cross sections are dominant just below the ΣN threshold, but one is not resonant there as it was with the earlier model. (auth)

59887 PHENOMENOLOGICAL STUDY OF s-SHELL HYPERNUCLEI WITH ΛN AND ΛNN POTENTIALS. Dalitz, R. H. (Oxford Univ.); Herndon, R. C.; Tang, Y. C. Nuclear Phys.; B47: No. 1, 109-37(1972).

The binding-energy data of the s-shell hypernuclei and the low-energy Λp scattering data are analyzed in terms of a simple model which employs both a Λ-nucleon (ΛN) and a Λ-nucleon—nucleon (ΛNN) potential. The ΛN potential is chosen to be central, with a hard core of radius 0.45 fm and an intrinsic range of 2.0 fm, and to have a charge-symmetry-breaking component. Two types of ΛNN potential are considered in this investigation, one being a phenomenological central potential and the other being the strongly noncentral potential obtained by Bhaduri, Loiseau, and Nogami using a two-pion-exchange mechanism. The ΛN potential fitted to the B_Λ values for ${}^3_\Lambda$H, ${}^4_\Lambda$H, and ${}^4_\Lambda$He and to the Λp scattering data (total cross sections and forward-backward asymmetries) has a rather small degree of spin dependence and a strength in odd-parity states which is only 20 to 70% of that in even-parity states. This potential gives overbinding for ${}^5_\Lambda$He by more than 2 MeV. The effect on this overbinding problem of introducing a ΛNN potential into the analysis is carefully examined. It is shown that a repulsive central ΛNN potential does reduce the calculated value for $B_\Lambda({}^5_\Lambda$He) but that this is only by a negligible amount, for general reasons which are discussed. For the noncentral ΛNN potential, it is found that a proper account of nucleon—nucleon correlations in the hypernuclear wave functions can modify its effect greatly, to an extent depending on the cut-off radius d adopted in this potential. For small values of d(0.45 to 0.7 fm), this noncentral ΛNN potential actually increases the overbinding; for $d \gtrsim 0.7$ fm, it does give net repulsion but the reduction found in $B_\Lambda({}^5_\Lambda$He) is far too small to yield agreement between the calculated and experimental values. (auth)

59888 NEUTRONS IN PROTON FRAGMENTATION. Duimio, F.; Marchesini, G. (Univ. of Parma, Italy). Nucl. Phys.; B47: No. 1, 249-52(1972).

Peripheral dynamics is studied for the limiting fragmentation of protons into neutrons. The calculated distribution is discussed and compared with the one of proton fragmentation into protons. (auth)

59889 INCLUSIVE SINGLE-PARTICLE SPECTRA ACCORDING TO THE THERMODYNAMIC MODEL AND DOUBLE- AND SINGLE-PEAKED ln TAN½ θ DISTRIBUTIONS. Ranft, J. (Karl Marx Univ., Leipzig). Phys. Rev., D; 6: No. 7, 2055-7(1 Oct 1972).

Inclusive single-particle spectra are calculated according to the thermodynamic model in the form $dN/d(\ln \tan\frac{1}{2}\theta)$. At asymptotic energies the model using the weak thermodynamic bootstrap solution leads to double-peaked distributions whereas the model using the strong thermodynamic bootstrap solution leads to a central plateau. (auth)

59890 ANALYSIS OF INCLUSIVE DISTRIBUTIONS USING A STATISTICAL APPROACH. Sivers, Dennis; Thomas, Gerald H. (Argonne National Lab., Ill.). Phys. Rev., D; 6: No. 7, 1961-75 (1 Oct 1972).

A statistical approach to production amplitudes is used to investigate the consequences for inclusive spectra due to (1) conservation laws, (2) small transverse momenta, (3) small average inelasticity, and (4) an asymptotically constant inelastic cross section. An analytic approximation of phase-space integrals is employed. Features of one- and two-particle inclusive spectra are discussed in terms of their exclusive components; both analytic and numerical results are presented. As a specific example of the approach, the rapidity distributions for $pp \rightarrow \pi^-\pi^-X$ are compared with data at 21 GeV/c. The above assumptions cannot account for some features of the $\pi^-\pi^-$ spectra, indicating the necessity for additional dynamic input. (auth)

59891 π^-–^{4}He ELASTIC SCATTERING AT 8 GeV/c. Budgen, D. (Univ. of Durham, Eng.). Lett. Nuovo Cim.; 5: No. 2, 160-4 (9 Sep 1972).

The differential cross section for the elastic scattering of negative π-mesons from helium-4 at 7.76 GeV/c was calculated using the Glauber multiple scattering model. A number of nuclear-density forms were used. It is found that neither the more rigorous form of the πN amplitude nor the inclusion of a fully correlated Gaussian density distribution made any marked improvement in agreement between experiment and theory. (L.B.S.)

59892 CROSS SECTION FOR DEUTERON DISINTEGRATION BY π MESONS NEAR THE THRESHOLD. Kudryavtsev, A. E. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 2, 385-92(Aug 1972). (In Russian).

The cross section for the $\pi d \rightarrow \pi pn$ reaction near the threshold is obtained by summation of an infinite diagrams series. The reaction amplitude takes into account multiple rescattering of π mesons by the deuteron nucleons. Corrections to the amplitude due to the kinetic energy of the nucleons in the intermediate state and the p-wave amplitudes for πN scattering are taken into account in the single and double scattering terms. The reaction cross section is $10.9\,\epsilon^2$ μb, where ε is the excess of the π meson energy over its threshold value referred to the deuteron coupling energy. (auth)

59893 SIMPLE EXPLANATION OF CORRELATION DATA IN INCLUSIVE pp INTERACTIONS AT HIGH ENERGY. Fialkowski, K. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Lett.; 41B: No. 3, 379-82(2 Oct 1972).

The existing integral and differential data for two-particle correlations between negative pions produced in high-energy pp collisions are discussed. They are shown to be explained in a simple way by adopting the Feynman—Wilson two-component picture. The diffractive part of the distribution, which appears to be small, is evaluated from experimental data. For the nondiffractive interaction the conservation laws are assumed to play the dominant role in correlation effects. (auth)

59894 TRIPLE-REGGE PHENOMENOLOGY FROM FINITE-MASS SUM RULES IN SINGLE-PARTICLE INCLUSIVE REACTIONS. Bietti, A. (Univ., Rome). Lett. Nuovo Cim.; 5: No. 3, 249-52(16 Sep 1972).

A finite-mass sum rule is used to investigate the possibility of evaluating the parameters of the triple-Regge model at large missing mass by means of an integral over the low and intermediate missing mass region keeping S and t fixed. The effective cross sections for the reactions $p + p \rightarrow K^+(K^-)$ + anything and $p + p \rightarrow \pi^+(\pi^-)$ + anything at 24 GeV/c are calculated. (J.F.P.)

59895 INVESTIGATION OF ELASTIC NUCLEON–NUCLEON SCATTERING. Janouch, Z. (Technial Univ., Prague). Acta Tech. CSAV; 16: No. 6, 704-28(1971).

The results are summarized of experimental and theoretical study of elastic nucleon-nucleon scattering. Investigated were the measurement of the triple scattering depolarization transfer parameter D_t in elastic proton-proton scattering at an energy of 660 MeV and the phase-shift analysis of the elastic nucleon-nucleon scattering in a region of 10 to 750 MeV. 12 figures, 6 tables. (NSA of Czech)

59896 EXISTENCE OF FIREBALLS IN N–N COLLISIONS AT COSMIC RAY ENERGIES. Hamaguchi, Minoru (Tokushima Univ., Japan). Tokushima Daigaku Gakugei Kiyo, Shizenkagaku; 21: 1-6(Feb 1971).

A new method is proposed to identify the meson clusters and the fireballs produced in the ultrarelativistic N–N collisions. It is stressed that the criterion of the ordinary identification of the clusters and the fireballs in the use of the log tan θ plot is highly ambiguous. Then, these clusters must be presumed to be the meson lumps coupled strongly by some kind of interaction between several mesons produced in the collision process. (auth) (Japan)

59897 DEEP INELASTIC HADRONIC SCATTERING IN DUAL-RESONANCE MODEL. Huang, Kerson (Massachusetts Inst. of Tech., Cambridge). Springer Tracts Mod. Phys.; 62: 107-17 (1972).

From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

The behavior of inclusive hadronic interactions in the phase space far from the boundaries is explored. The pp inelastic scattering at high energies is considered in dual resonance model. The inclusive cross section is calculated and compared with experimental data for $p + p \rightarrow p$ + anything, $p + p \rightarrow \pi^+$ + anything, and $p + p \rightarrow \pi^-$ + anything. (L.B.S.)

59898 MICROSCOPIC VIEW OF INCLUSIVE SPECTRA. Schmidt, W.; Schneider, H. (Univ., Karlsruhe, Ger.). Phys. Lett.; 41B: No. 3, 315-20(2 Oct 1972).

p-, n-, and π-inclusive spectra for pp, pn, pBe, and pPb collisions at k = 10 GeV/c are calculated. The NN and πN reactions are predicted with a microscopic model, which can also be used in a nuclear cascade model to treat p–nucleus collisions. (auth)

59899 NUCLEON–NUCLEON SCATTTERING LENGTHS AND PADE APPROXIMANTS. Barlow, R. H.; Bergere, M. C. (CEN de Saclay, Gif-sur-Yvette, France). Nuovo Cim.; 11A: No. 3, 557-74(1 Oct 1972).

Within the framework of Padé approximants, a method is proposed to calculate the nucleon-nucleon scattering amplitude that eliminates the problem associated with the wrong threshold behavior of the one-pion-exchange contribution. This method is applied to calculate scattering lengths, using Yukawa theory and the linear and nonlinear σ-models. Good agreement is found with experiment, in particular for the Yukawa model and nonlinear σ-models. (auth)

59900 SEPARATION OF ISOTOPIC-SPIN-$\frac{1}{2}$ AND -$\frac{3}{2}$ πN SYSTEMS IN $pp \rightarrow N\pi N$ REACTIONS AT 6.6 GeV/c. Colton, E. (Univ. of California, Berkeley); Ming Ma, Z. Nuovo Cim.; 11A: No. 3, 590-6(1 Oct 1972).

Data for the reactions $pp \rightarrow p\pi^+n$ and $pp \rightarrow pp\pi^0$ at 6.6 GeV/c are used to obtain the cross sections for the production of isotopic-spin-$\frac{1}{2}$ and -$\frac{3}{2}$ πN systems as well as their mutual interference term. Invariant-mass and momentum transfer projections are presented. Comparisons are made with previous results at 6.92 and 19 GeV/c. (auth)

59901 CROSS-SECTION FOR HIGH-TRANSVERSE-MOMENTUM HADRON JET PRODUCTION IN THE PARTON MODEL. Montvay, I. (CERN, Geneva). Lett. Nuovo Cim.; 5: No. 1, 41-7(2 Sep 1972).

The differential cross section for high-momentum hadronic jet production in proton-proton interactions is calculated in the parton model under the following assumption: the process leading from the post-reaction parton configuration to the observed hadronic final state can be described in framework of the nova model of diffraction scattering. (L.B.S.)

59902 DEUTERON-STRIPPING REACTIONS AT HIGH ENERGY. Barry, George W. (Univ. of Chicago). Ann. Phys. (N. Y.); 73: No. 2, 482-524(Oct 1972).

The bootstrap principle suggests that nuclei ($B \geq 2$) should be granted equal status in the nuclear democracy, along with the ordinary ($B \leq 1$) hadrons, simply because they interact strongly. Naively, one might expect nuclei to lie on Regge trajectories, and nuclear reactions to be dual, with resonances in the direct channel building up Regge poles in the crossed channel. With these concepts in mind, the simplest deuteron-stripping reactions, viz., $p + p \rightarrow d + \pi^+$, $p + p \rightarrow d + \rho^+$, and $p + d \rightarrow d + p$, are examined in detail. Overall, the most satisfactory model is the one-pion-exchange (OPE) model of Yao. A revised version of the Yao model is presented; it gives a good description of the experimental $pp \rightarrow d\pi$ forward differential cross section from threshold up to the highest energies measured. Furthermore, the model quantitatively accounts for the high-energy behaviors of the $p + p \rightarrow d + \pi$ and $p + p \rightarrow d + \rho$ forward differential cross sections, which were recently found to have very puzzling high-energy behaviors. Canonical Regge behavior should set in only at much higher energies. The bumps in the resonance region of the $pp \rightarrow d\pi$ cross section do not represent genuine dibaryon resonances, but are merely manifestations of Δ-isobar excitation of one of the nucleons in the deuteron. These results suggest that nuclei do not lie on Regge trajectories, although they do couple to nonexotic trajectories. The OPE mechanism can account for the $pp \rightarrow d\pi$ cross section even at threshold, where the one-nucleon-exchange contribution is greatly suppressed by the p–d–n vertex form factor. A test of the general validity of the OPE model is made by applying it to $p + d \rightarrow d + p$ at high energy. The model gives an excellent (one-parameter) fit to the experimental differential cross section over a wide range of energies and backward angles. The excited-deuteron model of Kerman and Kisslinger is in principle equivalent to the OPE model. The OPE approximation corresponds to writing for the amplitude an unsubtracted dispersion relation in u, and then assuming that the π-N anomalous cut saturates the dispersion integral. In this approach, the absolute scale of the amplitude is calculable, whereas before it was left as a free parameter. The calculated normalization turns out to be somewhat larger than the experimental value, and to improve on this would require a much deeper understanding of the deuteron structure. Since nuclei apparently lie outside of the hadron bootstrap, it is speculated that nuclei may not be hadrons (strongly interacting particles) after all. Their exotic quantum numbers may render them "inert" to the SU(3)-symmetric strong force, leaving only the SU(3)-breaking medium-strong force through which they can bind together. (17 figures, 1 table, 75 references) (auth)

59903 LOW-ENERGY S-MATRIX THEORY OF NEUTRON–DEUTERON SCATTERING. Bower, Richard H. J. (Princeton Univ., N. J.). Ann. Phys. (N. Y.); 73: No. 2, 372-416(Oct 1972).

The feasibility of a pure S-matrix description for low-energy neutron–deuteron scattering is examined. Dispersion relations were assumed to exist and the leading left-hand contributions were determined, including those arising from several normal singularities and from two anomalous singularities. The distant left-hand singularities were handled parametrically. Sum rules, which used only the unitarity and analyticity properties of partial waves and (very importantly) were independent of break-up channels, were constructed to examine several important properties of partial waves with these singularities. By adjusting only the distant left-hand singularity structure, doublet S waves were produced with a triton bound state, the triton coupling constant, and low-energy phase shifts in good agreement with the experimental phase shifts. For the quartet S wave, low-energy phase shifts were obtained which agreed well with experimental results and which were insensitive to the distant left-hand singularity structure. These solutions also contained a ghost whose position was sensitive to the left-hand singularity structure. (16 figures) (auth)

59904 TOTAL CROSS SECTIONS AND CONE SLOPE: THEORY AND EXPERIMENT. Sukhorukov, S. T.; Ter-Martirosyan, K. A. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 1, 22-5(5 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 1, 32-7(5 Jul 1972).

The theory of complex angular momenta which takes into account the contributions of the Regge poles and the rescatterings by these poles allows one to find the asymptotic scattering amplitude. The theory is compared with the new data on the values of the total cross sections and on the slopes of the pp scattering cone. The total cross sections of various strong interactions are compared with the experimental data. (J.F.P.)

59905 NUCLEON–NUCLEON INTERACTION IN THE NON-LINEAR SIGMA MODEL. Turchetti, G. (Istituto Nazionale di Fisica Nucleare, Bologna). pp 2.58-2.70 of Advanced Computing Methods in Theoretical Physics. Vol. 1. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655–(Vol.1).

The Lagrangian for the nonlinear sigma model (N.L.M.) is developed from the renormalized linear sigma model (L.M.). The contribution to the one-loop NN amplitude is discussed. The N.L.M. is introduced as the limit of the Green functions for the L.M.; the results for the one-loop NN amplitude are presented. The phase shifts derived for the N.L.M. are discussed. (France)

59906 CALCULATION OF P AND Q FORM FACTORS FOR PROTON–PROTON INTERACTIONS. Naisse, J. P. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg.; 57: No. 10, 1137-66 (1971). (In French).

The problems presented by the calculation of form factors which occur in effective-range theory are studied systematically, instead of the calculation methods existing in the literature, for the precise analysis of the S-wave proton–proton interaction at low energies. A procedure is presented which permits most of the difficulties to be eliminated. Also reference values for the four first coefficients in the formulation of the effective range theory, corresponding to potentials commonly used to represent the pp interaction taking into account the Coulomb effects, are given. (tr–auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 59954, 59956, 59980, 60014, and 60027.

59907 (KFKI–72–43) DEFORMATION OF THE S0(2,C) SUBGROUP OF THE LORENTZ GROUP. Huszar, M. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1972. 14p. Dep. NTIS (U. S. Sales Only).

The two-dimensional complex sphere $S_1^2 + S_2^2 + S_3^2 = S^2$ forms a homogeneous space under the SL(2,C) group. The little group of a point in this space is the SO(2,C) group or the horospheric group T(2) according to whether $S \neq O$ or $S = O$. Deformation of the SO(2,C) group into T(2) is investigated and is demonstrated on unitary representations. This deformation is a counterpart to that of the little groups SO(3), E(2), SO(2,1) belonging to the hyperboloid family. (auth)

59908 PARAMETRIZATION OF SU(3) ORBITS IN E_8. Charap, J. M.; Davies, P. T. (Queen Mary Coll., London). J. Phys., A (London); 5: No. 4, 563-8(Apr 1972).

Using Michel and Radicati's description (1968) of the stratification of E_8 under the action of SU(3) a parametrization of the SU(3) adjoint representation was constructed in terms of invariants and angles. This is the SU(3) equivalent of the SU(2) change from cartesian coordinates to spherical polar. (auth)

59909 GENERAL FORM OF THE SU(3) GURSEY MATRIX. Barnes, K. J.; Dondi, P. H.; Sarkar, S. C. (Queen Mary Coll., London). J. Phys., A (London); 5: No. 4, 555-62(Apr 1972).

The general form of the unitary unimodular Gürsey matrix at the SU(3) level is found in terms of a general hermitian octet vector. The relevance to chiral lagrangian theories of hadron physics is discussed, and other applications are suggested. (auth)

59910 LIE THEORY AND THE LAURICELLA FUNCTIONS F_D. Miller, Willard Jr. (Univ. of Minnesota, Minneapolis). J. Math. Phys. (N.Y.); 13: No. 9, 1393-9(Sep 1972).

It is shown that the Lauricella functions F_D in n variables transform as basis vectors corresponding to irreducible representations of the Lie algebra sl(n + 3, C). Group representation theory can then be applied to derive addition theorems, transformation formulas, and generating functions for the F_D. It is clear from this analysis that the use of SL(m, C) symmetry in atomic and elementary particle physics will lead inevitably to the remarkable functions F_D. (auth)

59911 SYMMETRIC GROUP AND THE GEL'FAND BASIS OF U(3). GENERALIZATIONS OF THE DIRAC IDENTITY. Lezuo, K. J. (Univ., Mainz). J. Math. Phys. (N. Y) · 13: No. 9, 1389-93(Sep 1972).

It is shown that the symmetrization of N particle states by means of the orthogonal units of the algebra of the symmetric group S_N yields the Gel'fand basis states of the irreducible representations of U(3). The existence of generalizations of the Dirac identity is demonstrated, and a connection between the symmetrized two- and three-body exchange operators and the invariants of U(3) is established. (auth)

59912 SYMMETRIC TENSOR OPERATORS OF THE UNITARY GROUPS. Alisauskas, S. J.; Jucys, A.-A. A.; Jucys, A. P. (Inst. of Physics and Mathematics, Vilnyus, USSR). J. Math. Phys. (N. Y); 13: No. 9, 1329-33(Sep 1972).

The algebraic expressions for the matrix elements of symmetric tensor operators (the powers of infinitesimal operators) of the unitary groups in the Gel'fand basis were studied. The expressions for the isoscalar factors of the related Clebsch–Gordan coefficients, one of the two representations to be coupled being symmetric, as well as the elements of a special recoupling matrix were found. The supplementary symmetry properties of the isoscalar factors corresponding to the Regge symmetries of Wigner and 6j coefficients of SU_2 were examined. (auth)

59913 NEW FORM FACTORS IN THE DUAL RESONANCE MODEL. Willemsen, J. F. (Univ. of Chicago). Contract AT(11-1)-264. Phys. Lett.; 41B: No. 3, 304-10(2 Oct 1972).

A new set of fields, satisfying a Moebius-invariant equation, is used in a dual model of vector currents. The elastic form factor exhibits power-law falloff, but the inelastic νW_2 structure function does not scale. (auth)

59914 MATRIX AND TENSOR CONSTRUCTIONS FROM A GENERIC SU(n) VECTOR. Barnes, K. J.; Delbourgo, R. (Queen Mary Coll., London). J. Phys., A (London) · 5: No. 7, 1043-53 (Jul 1972).

Projection operators appropriate to the general multispinor representations of SU(n) are constructed in a systematic way from the components of a single generic SU(n) vector transforming as the adjoint representation. The techniques were devised with the problems of writing explicit forms for finite SU(n) rotations and nonlinear chiral Lagrangians kept specifically in mind. In particular, the general second-rank tensors constructed from a single vector are found, counted, and exhibited in a very tractable form. (auth)

59915 SCALING PROPERTIES OF SPIN-$^1/_2$ OPERATORS. Genz, H. (Univ., Karlsruhe, Ger.); Katz, J. Nuovo Cim.; 11A: No. 3, 627-44(1 Oct 1972).

The assumption that a spin-$^1/_2$ field ψ has a unique dimension is investigated within the framework of scale and internal-symmetry breaking and linear current-field algebra. Expressions for the equal-time commutators $\int d^3x[\partial^\mu J_\mu^a(x), \psi(0)]$ and $[J_k^a(x), \psi(0)]$ (where J_μ^a denotes the $SU_2 \otimes SU_2$ currents) are given for theories in which the fermion source term has a unique dimension (in terms of the scale dimensionalities of $\partial^\mu J_\mu^a$, J_k^a, ψ and the source). It is found that the fermion source term cannot have a unique dimension for $M \neq 0$ if both of these commutators vanish. Additional sufficient conditions in order for the source to have mixed dimensions are also given in terms of the scale dimensionalities of $\partial^\mu J_\mu^a$ and J_k^a (denoted by l_d and l_k, respectively). For $l_d \neq 3$ and $l_k \neq 3$ and for fermion sources with arbitrary mixed dimensions the existence of parts of the source with certain dimensions is established if either of the commutators $\int d^3x[\partial^\mu J_\mu^a(x), \psi(0)]$ or $[J_k^a(x), \psi(0)]$ is nonvanishing. The equal-time commutators $[\theta_\mu^\mu(x), \overline{\psi}(0)\gamma_0]$, $[u(x), \overline{\psi}(0)\gamma_0]$ and $[\delta(x), \overline{\psi}(0)\gamma_0]$ (where $\theta_{\mu\nu}$ denotes the energy-momentum tensor, u the $SU_2 \otimes SU_2$-symmetry-breaking part of θ_{00} and δ the $SU_2 \otimes SU_2$ singlet part of θ_{00} which breaks dilatation invariance even in the chiral limit) are calculated in terms of parts of the fermion source with fixed dimension. As a particular result it is noticed that in a model with a free (for $M \neq 0$) fermion field $l_k = l_d = 3$ follows. (auth)

59916 AXIAL VECTOR CURRENT AND PCAC IN THE σ-MODEL. Maurer, R. H.; Willey, R. S. (Univ. of Pittsburgh). Ann. Phys. (N. Y.); 73: No. 2, 461-81(Oct 1972).

An explicit operator construction of the axial vector current in the boson σ model is given in perturbation theory. This current is finite and satisfies the PCAC condition with the renormalized pion field. It also (at least formally) satisfies the $SU_2 \times SU_2$ equal-time time-component current algebra. (auth)

59917 DYNAMICAL SOLUTION TO THE SUGAWARA MODEL. II. THE LIE IDENTITIES. Joseph A. (Tel-Aviv Univ., Israel). Ann. Phys. (N. Y.); 73: No. 2, 417-38(Oct 1972).

Following the development of the first paper of this series, the current–current commutator in the Sugawara current algebra model is examined. A more elegant derivation of this commutator from its equal-time values and the equation of motion of the currents is described; and the final result given a more compact and simple form. The behavior of the commutator with respect to the Lie identities, in particular the Jacobi identity, is studied in some detail. It is pointed out that, as it stands, the commutator does not satisfy these relationships identically, a difficulty which is attributed to differences in current orderings in the expression for the double commutator. Thus it is shown, by detailed algebraic computation, that, within a well-defined framework in which the different possible orderings of the currents are identified, the Lie relations are satisfied identically. Without this identification it is further shown through the analysis of a simplified model that the symmetrization of operator products in the expression for the commutator, which gives the correct antisymmetry, is not sufficient to recover the Jacobi identity. The possible connection of the singularity structure of the model with the requirements imposed by the Lie identities is discussed. Finally, a generalization of the model is described in which the currents are not conserved, however, their divergence is shown to define a scalar canonical field, and its canonical momentum is computed. (auth)

59918 IRREDUCIBLE UNITARY REPRESENTATIONS OF A POINCARE-TYPE GROUP AND ITS UNIFICATION WITH THE POINCARE GROUP. Piard, Alain (Univ., Dijon, France). Compt. Rend., Ser. A; 274: No. 23, 1663-6(5 Jun 1972). (In French).

All the highly continuous irreducible representations of these two groups were determined using the induced representation method. (France)

Applications (Electromagnetic and Weak)

Refer also to abstract 59813.

59919 LEPTON NUMBER CONSERVING AND NON-CONSERVING WEAK INTERACTIONS. Freund, P. G. O. (Univ. of Chicago). Nucl. Phys.; B47: No. 1, 200-4(1972).

A gauge theory of weak and electromagnetic interactions based on a group containing the SU(4) group of unitary unimodular transformations on the lepton and quark quartets, is shown to be possible only if lepton and/or baryon number are not exactly conserved, or if there exist particles that cannot be built of quarks and leptons. The spontaneous breakdown of lepton number conservation in terms of tadpole-producing spinless leptons is considered. (auth)

59920 MODELS OF WEAK AND ELECTROMAGNETIC INTERACTIONS. Prentki, J.; Zumino, B. (CERN, Geneva). Nucl. Phys.; B47: No. 1, 99-108(1972).

Two models of weak and electromagnetic interactions are described which are based on the spontaneously broken gauge group associated with SU(2) × U(1). In the first model the neutrino field does not appear in the neutral current, in the second it appears only in combination with a heavy neutral lepton. As a consequence, elastic neutrino–proton scattering and elastic μ-neutrino electron scattering are absent in both models. The extension of hadrons is discussed. Finally, a number of observations on unified theories are made. (auth)

59921 POSSIBLE CPT-BREAKING EFFECTS AND $K_L \rightarrow 2\mu$ DECAY. Bogomal'nyi, E. B.; Dolgov, A. D.; Zakharov, V. I.; Okun, L. B.; Teret'ev, M. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 15: No. 5, 985-94(May 1972). (In Russian).

A CPT noninvariant interaction with the coupling constant $\sim 10^{-12}$ could explain the experimental data on $K_L^0 \rightarrow \mu\bar{\mu}$ decay. Possible effects of such an interaction in various weak decays are considered. (auth)

59922 MODIFIED ALGEBRA OF CURRENTS IN BROKEN CHIRAL SYMMETRY. Thebaud, Lawrence (Harvard Univ., Cambridge, Mass.). Ann. Phys. (N. Y.); 73: No. 1, 210-56(Sep 1972).

A method of relaxing the usual hypothesis that the algebra of currents is unaffected by chiral symmetry breaking is proposed and investigated. While the equal-time SU(3) ⊗ SU(3) charge algebra is retained, the space components of the currents are allowed to transform generally among themselves under commutation with the nonconserved charges, resulting in a modified current algebra containing five real parameters of the symmetry breaking. It is found that manifest covariance in low-energy theorems is destroyed, necessitating introduction of new techniques for sharpening the role of pion pole dominance and SU(3) symmetry. These techniques lead to the conclusion that the predictions of current algebra for pion scattering lengths G_A/G_V and hyperon decays are unchanged, whereas those for π_{13} decay and the connections among K_{12}, K_{13}, and K_{14} decays are altered in definite ways, as is Weinberg's first-sum rule. All of the predictions for leptonic K-decays are found to involve only one of the five symmetry breaking parameters; kaon experiments therefore provide both measurements of one of the new parameters and tests of the original hypothesis of a generalized current algebra. Present experimental data are, however, not sufficiently accurate for this purpose. (auth)

59923 RENORMALIZABLE MODEL OF WEAK AND ELECTROMAGNETIC INTERACTIONS WITH CP VIOLATION. Mohapatra, Rabindra N. (Univ. of Maryland, College Park). Phys. Rev., D; 6: No. 7, 2023-8(1 Oct 1972).

A renormalizable gauge-field model of weak and electromagnetic interaction of leptons and hadrons is constructed. The model can explain CP violation in hadronic weak processes and the suppression of hadronic neutral currents. (auth)

59924 WHO DO RESONANCES SCALE. Elitzur, M. (Rockefeller Univ., New York); Susskind, L. Phys. Rev., D; 6: No. 7, 2003-9(1 Oct 1972).

Scaling of hadronic resonance excitation is discussed within the framework of a simple potential-theoretic parton model. (auth)

59925 CP VIOLATION AND RADIATIVE NEUTRAL-KAON DECAYS INTO LEPTON PAIRS. Miyazaki, T. (Tokyo Univ.). Lett. Nuovo Cim.; 5: No. 2, 125-30(9 Sep 1972).

The ratio $\Gamma(K_{S,L} \rightarrow l\bar{l}\gamma)/\Gamma(K_{S,L} \rightarrow \gamma\gamma)$ is calculated under the assumption of CP nonconservation and the assumption that the main contribution to $K_{S,L} \rightarrow l\bar{l}\gamma$ comes from the two-photon intermediate state. It is found that this ratio is not affected by the CP-nonconserving vertices nor by the superweak theory of CP violation; the deviation of the theoretical values from the experimental ones, therefore, would imply contributions of the other intermediate states. It is suggested that experiments which measure $\Gamma(K_{S,L} \rightarrow l\bar{l}\gamma)/\Gamma(K_{S,L} \rightarrow \gamma\gamma)$ would be a straightforward determination of the ways of solving the $K_L \rightarrow \mu^+\mu^-$ puzzle. (L.B.S.)

59926 STATUS OF THE CABIBBO–RADICATI SUM RULE AND A NEW TEST OF VECTOR MESON DOMINANCE. Gounaris, D. J. (CERN, Geneva). Phys. Lett.; 41B: No. 3, 329-33(2 Oct 1972).

By means of finite energy sum rules the high-energy contribution to the Cabibbo–Radicati sum rule is calculated and shown to be of the proper magnitude and sign, so that this sum rule is exactly satisfied. In addition, the coupling of the ρ Regge trajectory to two charged photons is calculated and found to be in agreement with the predictions of vector meson dominance and universality for the Reggeized ρ vertex, within the expected accuracy. (auth)

Applications (Strong)

Refer also to abstract 59830.

59927 REMARKS ON NONUNIQUENESS OF EFFECTIVE LAGRANGIAN IN CHIRAL SU(2) x SU(2) SYMMETRY. Nguyen Van Hieu. Yadern. Fiz.; 15: No. 5, 1016-19(May 1972). (In Russian).

The physical conditions were formulated at which the effective Lagrangians of $\pi\pi$-and πN-interactions are unambiguous. (auth)

59928 QUESTION OF PCAC AND OF THE CHIRAL SU(2) x SU(2) SYMMETRY. Sebastian, K. J. (Lowell Technological Inst., Mass.). Nucl. Phys.; B47: No. 1, 301-12(1972).

The recent work of Brandt and Preparata on "weak PCAC" and chiral SU(2) × SU(2) symmetry is analyzed. By making use of the analyticity properties and Regge asymptotic behavior of a four-point amplitude it is investigated whether the "weak PCAC" is really weak and in what respects exactly it differs from the usual formulation of PCAC. It is found that one must distinguish between two possible formulations namely "weak PCAC I" and "weak PCAC II." It is shown that "weak PCAC I" is equivalent to "strong PCAC" as far as the four-point Green's functions are concerned. This leads to the result that within the frame-work of the model of SU(3) × SU(3) breaking by Gell-Mann, Oakes and Renner (GMOR) they are completely equivalent. On the other hand "weak PCAC II" is indeed weaker than "strong PCAC." Also some remarks about "weak PCAC" outside the frame-work of the GMOR model are made. (auth)

59929 BREAKING CHIRAL AND SCALE SYMMETRY OF A LAGRANGIAN WITH MASSIVE GAUGE FIELDS. Hudnall, W. (Syracuse Univ., N. Y.). Phys. Rev., D; 6: No. 7, 1953-7(1 Oct 1972).

The effects of adding the $1^{\pm}$ gauge fields to an SU(3) σ model of the $0^{\pm}$ fields are investigated. Particular attention is given to the requirements of broken scale invariance on the simple model where the "(3,3*)"-chiral- and scale-symmetry-breaking terms coincide. The mass spectrum and the scalar-meson trilinear decay widths are also calculated. (auth)

59930 O(n) RELATIONS FOR COUPLING CONSTANTS AND SPACE–TIME DIMENSIONS IN DUAL MODELS. Frampton, P. H. (CERN, Geneva). Phys. Lett.; 41B: No. 3, 364-70(2 Oct 1972).

It is proposed that certain daughter trajectories arise as a consequence of a higher underlying O(n) symmetry, with $n > 3$. This suggestion is motivated by the dual resonance model, where such a pattern arises naturally from the existence of a critical space–time dimension. This is easily confirmed in the model (and provides a simple test for what is the critical dimension) by considering the amplitudes for spinless particles. The results of πN phase shift analysis are discussed to give a speculative phenomenological estimate of the appropriate higher symmetry. (auth)

59931 PREDICTION, SUPPORTED BY DATA, OF A QUALITATIVE BREAKING OF SU3 FOR BARYON RESONANCE DECAY RATES. Odorico, R. (Argonne National Lab., Ill.). Phys. Lett.; 41B: No. 3, 339-44(2 Oct 1972).

In the light of recently reported difficulties met by SU3 in comparisons with experimental decay rates of baryon resonances, an alternative scheme is presented which provides a simple understanding of yet unexplained features of baryon resonance data, and which implies a qualitative breaking of SU3 for baryon resonance decay rates. (auth)

59932 CANONICAL SECOND RANK TENSORS FOR CHIRAL SU(3) x SU(3). Barnes, K. J. (Queen Mary Coll., London). J. Phys., A (London); 5: No. 6, 830-7(Jun 1972).

The general second-rank SU(3) tensor formed from a single hermitian octet vector is expressed in terms of a base set constructed to have particularly simple properties. The relevance to chiral lagrangian theories of hadron physics is discussed, and other applications are suggested. (auth)

59933 MASS SPLITTING IN RELATIVISTIC SU_3. Almond, D. J. (Univ. of Southampton, Eng.). Lett. Nuovo Cim.; 5: No. 3, 233-5(16 Sep 1972).

It is found that there is no hadron mass splitting in nonrelativistic SU(3) if it is required that the operators commute with the generators of the nonrelativistic space–time transformations. The mass splitting in SU(3) is found to be a specifically relativistic effect which must go to zero as $c \rightarrow \infty$. (J.F.P.)

59934 U(6,6) SYMMETRY AND THE GENERALIZED VENEZIANO MODEL FOR $K^-p \rightarrow K^{*-}\pi^+n$. Barkai, D. (Imperial Coll. of Science and Tech., London); Moriarty, K. J. M. J. Phys., A (London); 5: No. 9, 1364-73(Sep 1972).

U(6,6) symmetric kinematic factors are combined with the generalized Veneziano model. The model is applied to $K^-p \rightarrow K^{*-}\pi^+n$. Some arbitrariness of parameters is removed and comparisons with the data show the results are at least as good as in previous models. (auth)

59935 CHIRAL SU(2) × SU(2) DYNAMICS AND REACTION $\pi^+p \rightarrow \rho^0\Delta^{++}_{1236}$ NEAR THE THRESHOLD. Zaslavskii, A. N.; Lednitski, R. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 16: No. 2, 416-26(Aug 1972). (In Russian).

The reaction $\pi^+p \rightarrow \rho^0\Delta^{++}_{1236}$ is studied in the framework of current algebra with the method of effective Lagrangians. The total amplitude contains 10 parameters, which are fitted from the differential cross sections at the energies in the c.m.s. 2.194 and 2.302 GeV and from the joint spin density matrix of ρ^0-mesons and isobar Δ^{++}_{1236} at the energy 2.302 GeV; in this 105 experimental points are used. The results of the current algebra are in satisfactory agreement with the experimental data. (auth)

59936 DYNAMIC SYMMETRIES. THE - 1/R POTENTIAL. Gyorgyi, Geza (Central Research Inst. for Physics, Budapest). Magy. Fiz. Foly.; 20: No. 2, 166-99(1972). (In Hungarian).

Kepler's centuries-old $-1/r$ potential problem still attracts considerable attention because of its mathematical symmetries. The current interest is related to recently developed hadron-physical concepts of the group theory, involving the SU(3) systematics and the eightfold way, the prediction of the Ω^- hyperon and the correlations between the SU(6) supermultiplets and magnetic moments. The classical Kepler problem is discussed from a new angle, indicating the invariance symmetry of the SO(4) and SO(3,1) groups with respect to bound states. A four-dimensional geometry was employed in the discussion, introducing a τ-invariant time parameter. The four-vector character of π_α explained the SO(4) invariance symmetry, demonstrated by Fock's stereographic projection. The four-dimensional invariance symmetry was used as the basis for the derivation of Kepler orbits and hodographic paths. The τ time parameters indicated that the Fock variables have a canonical character, showing the proportionality of the eccentric anomaly introduced by Kepler. The study revealed correlations in the dynamic symmetries of the Newton and Coulomb potentials which are inversely proportional with the distance. (Doctoral dissertation). (TTT)

Field Theories

General

59937 ISOLATED CHARGE DISTRIBUTION IN UNIFIED FIELD THEORY. Pant, D. N. (Banaras Hindu Univ., India). Acta Phys. Acad. Sci. Hung.; 31: No. 4, 285-91(1972).

Einstein's unified field theory equations (1953) were considered in order to find the external field of an isolated charge distribution for a special axially symmetric case. The field equations were solved in two cases. In one case the space-time becomes flat and the electrostatic field is found to be constant in the direction of the axis of symmetry. The solution for the other case is nonexistent. (auth)

59938 SIMPLE COUPLING BETWEEN THE ELECTROMAGNETIC AND GRAVITATIONAL FIELDS. Majernik, V. (Inst. of Physics, Bratislava). Lett. Nuovo Cim.; 5: No. 2, 165-71(9 Sep 1972).

The field equations of gravitation are written in the form of Maxwell's field equation, following an analogy between the gravitational field and the electromagnetic field characterized by four vectors. The field equations for the coupled electromagnetic and gravitational field are obtained. Solutions are obtained for the stationary symmetric source-free coupled fields and for the case where the source of the gravitational field is a mass point. The consequences of the coupled field equations are discussed. (L.B.S.)

59939 GENERAL METHOD OF INTEGRATING SCHROEDINGER'S EQUATION WITH THE SINGULAR RIGHT-HAND SIDE IN A HOMOGENEOUS AND CONSTANT ELECTROMAGNETIC FIELD. Thai Quang. Zh. Vychisl. Mat. i Mat. Fiz.; 12: No. 2, 489-91(1972). (In Russian).

A general method of integrating the Schroedinger equation was proposed with the singular right-hand part in a homogeneous and constant electromagnetic field. This method was used for deriving the retarded Green function of the equations of Schroedinger and Pauli in a homogeneous and constant electromagnetic field. The field vectors of the latter are assumed to be disposed at an arbitrary angle to each other. (tr-auth)

59940 ELEMENTARY PARTICLES AND GENERAL RELATIVITY. Basano, L. (Univ., Genoa). Lett. Nuovo Cim.; 5: No. 1, 19-22(2 Sep 1972).

Values for the electron and proton radii were derived by Ross (Nuovo Cimento, 8A, 603 (1972)) by combining the Einstein field equations (respectively for the Coulomb and Yukawa fields) with the principle of the stationary metric. An exact and general solution to the field equations is given, which encompasses Ross' results as special cases. The particle model implied by Ross' work is briefly discussed, with special attention given to the field energy density and the self-consistency of the method. (L.B.S.)

59941 DERIVATIVES: FORMS AND USUAL OPERATORS ON THE SPINORIAL FIELDS OF DIFFERENTIABLE VARIETIES HAVING EVEN DIMENSIONS. Crumeyrolle, A. (Univ., Toulouse). Ann. Inst. Henri Poincare, Sect. A; 16: No. 3, 171-201(1972). (In French).

Concepts concerning covariant derivatives and Lie derivatives for spinor and tensor-spinor fields that avoid the matrix formalism were introduced. It is shown how the impossibility of naturally extending classical Riemann techniques to spinors is linked to the impossibility (in general) of reducing the structural group of the fiber of the orthogonally normalized references to one of the so-called-spinorial groups. A procedure which is direct, concrete, and intrinsic can be used to yield all the classical formulas from such a variety. (France)

59942 PARTICLE BOUNDEDNESS IN $\gamma^i_{jk;l} = 0$, $g_{ij;k} = 0$ FIELD THEORY. Muraskin, M.; Ring, B. (Univ. of North Dakota, Grand Forks). Int. J. Theor. Phys.; 6: No. 2, 105-9(Aug 1972).

The problem of particle boundedness in field theory was studied based on the equations $\gamma^i_{j;kl} = 0$ and $g_{ij;k} = 0$. No evidence of boundedness was found. However, this negative result may be the result of using too simplified a solution to the integrability equation. (auth)

59943 CONSIDERATIONS ON A UNIFIED FIELD THEORY. Cohn, J. (Univ. of Oklahoma, Norman). Int. J. Theor. Phys.; 6: No. 2, 123-31(Aug 1972).

A geometrical formulation of gravitational and electromagnetic fields is presented for systems composed of point-mass charged particles where the charge is small enough that electromagnetic radiation may be neglected. It is assumed that such charges produce a nonnegligible contribution to the metric, and that their motion describes geodesics in the total metric which consists of that due to the charge itself and that due to the external environment of the charge. The above, together with several other assumptions yields the customary Einstein–Maxwell relations. It is demonstrated that this construction is not merely a re-statement of the Einstein–Maxwell theory in different terms. (auth)

59944 DIAGRAMMATIC TECHNIQUE IN SCATTERING THEORY FOR A UNIFIED FIELD OF SCALAR ELECTRODYNAMICS. Kuvshinov, V. I.; Fedorov, F. I. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 3, 56-66(1972). (In Russian).

A formalism of excitation theory was constructed for scattering of a unified field in scalar electrodynamics. The amplitude of N-tails possesses N! terms, distinguished by permutations of external momenta. The momentum portion of the amplitude was invariant to crossing and twisting transformations. Among N! terms the amplitudes were shown equal to each other, and the diagrams of which were associated with reflections from the axis of symmetry. (tr-auth)

59945 INTERACTION THEORY OF THE ELECTROMAGNETIC FIELD. Schwebel, S. L. (Boston Coll., Chestnut Hill, Mass.). Int. J. Theor. Phys.; 6: No. 1, 61-74(Aug 1972).

An analysis of the field concept and its description in terms of field variables leads to the development of an interaction theory of the electromagnetic field with the following properties: it is free of self-interaction terms; the point charge model remains a viable conceptual element of the theory; radiative reaction is fully accounted for within the framework of the theory and is not an ad hoc addition as in conventional theory; neither a single charged particle nor a system of interacting charged particles radiates to a mathematical sink at infinity. Radiation occurs only between and among the interacting particles. Energy and momentum are transferred only between and among the particles; conventional conservation laws and forces are generalized; and new conservation laws and forces appear. An application to a system of two interacting particles reveals in detail the conservation of energy, linear and angular momentum. Moreover, an intrinsic angular momentum of constant magnitude—a sort of classical helicity—appears. The significance of these results to the further development of electromagnetic theory and quantum theory is briefly discussed. (auth)

59946 FIELD THEORY WHERE ALL Γ^i_{jk} INVARIANTS VANISH. Muraskin, M. (Univ. of North Dakota, Grand Forks). Int. J. Theor. Phys.; 6: No. 1, 37-45(Aug 1972).

An investigation is made as to whether a nontrivial field theory exists for which all scalars formed from Γ^i_{jk} (where g_{ij} is used to raise and lower indices) can be zero for all points of space and time. Some examples are found for which the invariants are all zero for all points at which the field is finite. The problem of boundary conditions in general is considered. (auth)

59947 CENTRALLY-SYMMETRIC STATIC FIELD OF A CHARGED MASS IN A SPACE OF AFFINE COHERENCE WITH THE RIEMANN METRIC AND DISTORSION. Tunyak, V. N. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 2, 114-17(1972). (In Russian).

An accurate self-consistent solution was obtained which described the central-symmetric static field of a charged mass in a space of affine coherence with a Riemann metric and torsion. The completely observed mass of the charged source was determined. The corresponding classical model of the electron was considered. (tr-auth)

59948 NEW INTERPRETATION OF EINSTEIN'S UNIFIED FIELD. Russell, G. K.; Klotz, A. H. (Univ. of Sydney). Acta Phys. Pol.; B3: No. 4, 407-12(1972).

It is proposed that the electromagnetic field in the nonsymmetric unified field theory should be related to the skewsymmetric part of the fundamental tensor by a second grade differential operation. The form of this relation suggested leads to a correction factor in the Coulomb law. (auth)

59949 CYLINDRICAL SYMMETRY IN EINSTEIN'S UNIFIED FIELD THEORY. III. Klotz, A. H.; Russell, G. H. (Univ. of Sydney). Acta Phys. Pol.; B3: No. 4, 413-19(1972).

A cylindrically symmetric solution of Einstein's unified field equations is derived for the case when neither of the fields tentatively interpreted as electro- and magnetostatic vanishes. The form of the solution suggests a new interpretation of the geometry which will be proposed separately. (auth)

Quantum Field Theory

Refer also to abstracts 59683, 59732, 59764, 59834, and 59872.

59950 (SLAC-PUB-1052) SEMI-CLASSICAL RADIATION THEORY AND HIGH ENERGY MULTIPRODUCTION. Stodolsky, L. (Stanford Linear Accelerator Center, Calif.). Jun 1972. 23p. (CONF-720333-4). Dep. NTIS.

From seventh rencontre de moriond conference; Meribel-les-Allues, France (5 Mar 1972).

Lectures are given on the secondary spectrum and an analogy between radiative tails for straggling in electrodynamics and leading particle behavior in high energy multiproduction by hadrons. (J.F.P.)

59951 (TID-26185) NEW SCALAR AND CONSERVED VECTOR CURRENTS IN DUAL RESONANCE MODELS. Tze, Hsiung Chia (Chicago Univ., Ill. Argonne National Lab., Ill.). Jul 1972. Contract AT(11-1)-264. 15p. Dep. NTIS.

A complex conformal scalar field allows a simple formulation of the Rebbi–Drummond Model. It leads to new dual models of scalar and conserved vector currents when the conformal spinor fields of the dual Thirring model are also included. (auth)

59952 CLASSICAL PARASTOCHASTICS AND QUANTUM MECHANICS: SOME OBSERVATIONS. Bourret, R. (Observatoire de Paris, Meudon, France). J. Phys., A (London); 5: No. 4, 495-8(Apr 1972).

Modified commutation relations which have been used in a classical stochastic context are shown to be similar, in a simple quantum mechanical example, to the modification of the potential. In quantum field theory their effect is to yield a nonlinear field equation for a free scalar boson. It is concluded that such modified commutation relations are incompatible with quantum mechanics. (auth)

59953 RELATIVISTIC THEORY OF MAGNETOELASTIC INTERACTIONS. I. Maugin, G. A. (Princeton Univ., N. J.). J. Phys., A (London)· 5: No. 6, 786-802(Jun 1972).

The relativistically invariant field equations relevant to mechanics, thermodynamics, and electromagnetism are presented in a phenomenological continuum theory of magnetoelastic interactions in which the magnetic spin is accounted for. (auth)

59954 UNITARY REPRESENTATIONS OF THE HOMOGENEOUS LORENTZ GROUP IN AN 0(1,1) x 0(2) BASIS AND SOME APPLICATIONS TO RELATIVISTIC EQUATIONS. Kalnins, E. G. (Univ. of Western Ontario, London). J. Math. Phys. (N. Y); 13: No. 9, 1304-12(Sep 1972).

Unitary irreducible representations of the homogeneous Lorentz group O(3, 1) belonging to the principal series are reduced with respect to the subgroup $O(1, 1) \otimes O(2)$. As an application the mixed basis matrix elements between O(3) and $O(1, 1) \otimes O(2)$ bases are determined and recurrence relations are derived for them. This set of functions is then used to obtain invariant expansions of solutions of the Dirac and Proca free field equations. These expansions are shown to have the correct nonrelativistic limit. (auth)

59955 ANHARMONIC OSCILLATOR WITH POLYNOMIAL SELF-INTERACTION. Banks, Thomas I. (Massachusetts Inst. of Tech., Cambridge); Bender, Carl M. J. Math. Phys. (N. Y); 13: No. 9, 1320-4(Sep 1972).

A quantum anharmonic oscillator with a polynomial self-interaction is defined in coordinate space by a Hamiltonian of the form $H = -d^2/dx^2 + {}^1\!/_4x^2 + g[({}^1\!/_2x^2)^N + a({}^1\!/_2x^2)^{N-1} + b({}^1\!/_2x^2)^{N-2} + \ldots]$. Using WKB techniques a secular equation is derived which determines the eigenvalues of H for small $|g|$. It is found that the qualitative analytic structure of these eigenvalues as functions of complex g remains unchanged for all fixed values of a, b, . . . , including $a = b = \cdots = 0$. The secular equation also implies an elegant theorem which predicts how the a, b, ⋯ terms in H affect the large-order growth of perturbation theory. This theorem is used to compare the perturbative behavior of non-Wick-ordered and Wick-ordered field theories in one-dimensional space-time. In particular, it is shown that the perturbation series $\Sigma A_n g^n$ and $\Sigma B_n g^n$ for the energy levels of the $(g\psi^{2N})_1$ and $(:g\psi^{2N}:)_1$ field theories differ in large order by an over-all multiplicative constant $\lim_{n\to\infty} A_n/B_n = \exp[N(2N-1)/(2N-2)]$. (auth)

59956 WARD–TAKAHASHI RELATIONS IN MASSIVE YANG–MILLS THEORY. Barnebey, T. A. (Univ. of California, Los Angeles). J. Math. Phys. (N. Y); 13: No. 9, 1355-68(Sep 1972).

The equivalence of massive Yang–Mills theory in the simplest gauge to a theory of vector electrodynamics is reviewed. The resultant Feynman rules and SU(2) invariance are used to derive Ward–Takahashi relations among the corrected vertices which are valid to all orders. One of these is employed to find a new Ward identity. A brief discussion of divergence problems is given. (auth)

59957 QUANTUM DYNAMICS OF HIGHER-DERIVATIVE FIELDS. Riewe, F.; Green, A. E. S. (Univ. of Florida, Gainesville). J. Math. Phys. (N. Y); 13: No. 9, 1368-74(Sep 1972).

The generalized quantum field theory which follows from Lagrangians containing arbitrarily high-order derivatives is formulated in an indefinite metric space. Particular attention is given to conservation laws and canonical commutation relations. The Heisenberg equations of motion are derived. (auth)

59958 CONNECTION BETWEEN NONLINEARITY OF THE POMERANCHUK TRAJECTORY AND AN INTERCEPT BELOW 1. Chew, G. F. (National Accelerator Lab., Batavia, Ill.); Snider, D. R. Phys. Rev., D; 6: No. 7, 2057-8(1 Oct 1972).

An order-of-magnitude relation is suggested between the curvature of the Pomeranchuk trajectory and the displacement of its intercept below 1. (auth)

59959 NONEQUIVALENCE BETWEEN CONFORMAL COVARIANT WILSON EXPANSION IN EUCLIDEAN AND MINKOWSKI SPACE. Ferrara, S.; Grillo, A. F.; Parisi, G. (CNEN; Frascati, Italy). Lett. Nuovo Cim.; 5: No. 2, 147-51(9 Sep 1972).

It is pointed out that a conformal covariant Wilson expansion cannot be done in Euclidean space in the usual sense. The correct conformal covariant prescription is found which has to be used in order to obtain the operator product expansion in the pseudo-Euclidean space-time. (L.B.S.)

59960 EXACT SOLUTIONS TO QUANTIZED FIELD THEORIES. Burt, P. B.; Reid, J. L. (Univ. of Clemson, S. C.). J. Phys., A (London); 5: No. 9, L88-90(Sep 1972).

Exact solutions to a class of one-dimensional quantum field theories described by the field equations $d^2\phi/dt^2 + m^2\phi + \lambda\phi^{2q+1} = 0$, $q \neq 0, -1$, and by boson commutation relations are given. For the special case $q = 1$ explicit solutions are discussed. The solutions described self-interacting systems for all times and contain arbitrary negative powers of m^2. (auth)

59961 MEASUREMENT OF 2e/h BY THE ac JOSEPHSON EFFECT. Petley, B. W.; Gallop, J. C.; Morris, K. (National Physical Lab., Teddington, Eng.). Phys. Bull. (London); 23: 457-61(Aug 1972).

The Josephson effect in superconductors is described together with its application in determining the atomic constant 2e/h, where e is the electron charge and h is Planck's constant. It is stated that the technique gives greater precision than has been achieved by other methods. Among matters discussed are: the fundamental constants; the AC Josephson effect; incident and emitted radiation; verification of the expression 2e/h; and the measurement technique. (UK)

59962 EQUIVALENCE THEOREM FOR A MASSIVE SPIN ONE PARTICLE INTERACTING WITH DIRAC PARTICLES IN QUANTUM FIELD THEORY. Jenkins, J. D. (Univ. of Durham, Eng.). J. Phys., A (London); 5: No. 5, 705-16(May 1972).

The $(1,0) \otimes (0,1)$ massive spin one field $\phi_{\mu\nu}(\chi)$ is quantized following the method of Takahashi and Umezawa (Prog. Theor. Phys., 9: 14-32; 501-23(1953)). The interaction Hamiltonian in the interaction picture is then calculated for such a field interacting in a simple way with Dirac fields. In contrast with a remark of Kyriakopoulos (Phys. Rev., 183: 1318-23(1969)), the generalized Matthews' theorem is found to apply to the calculation of S matrix elements. The analogous theory in terms of the Proca field is given in outline, and the two theories are found to be inequivalent. A discussion of how the inequivalence arises is given; then it is demonstrated how equivalent theories may be constructed, and the equivalence is proved. (auth)

59963 QUANTUM FIELD THEORIES WITH HOMOGENEOUS INTERACTIONS. Koller, K. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 5: No. 3, 213-20(16 Sep 1972).

A perturbation theory is proposed for homogeneous interactions of conventional renormalizable scalar fields ϕ^λ. These interactions are called homogeneous because they give rise in the massless case to Green functions which are homogeneous functions of space–time. Formulas for Green functions which are valid for all the complex values of λ are derived in perturbation theory. (J.F.P.)

59964 RENORMALIZED SCATTERING THEORY FOR THE LEE MODEL. Aref'eva, I. Ya. (Inst. of Mathematics, Moscow). Teor. Mat. Fiz.; 12: No. 3, 331-48(Sep 1972). (In Russian).

Existence of wave operators in an arbitrary sector of the Lee model is proved. The wave operators are defined in accordance with the general approach to scattering theory for models with momentum conservation suggested by L. D. Faddeev. (auth)

59965 SOLVABLE MODEL OF THE NONRENORMALIZABLE FIELD THEORY. Efremov, A. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 12: No. 3, 349-51(Sep 1972). (In Russian).

A solvable nonrenormalizable model of a spinless field current interacting with a fixed point-like charged source is considered. It is shown that the energy increase of the scattering amplitude in perturbation theory turns to the decrease of it in the exact solution. (auth)

59966 LEGENDRE TRANSFORMATIONS FOR GENERATING FUNCTIONALS IN QUANTUM FIELD THEORY. Kazanskii, A. K.; Vasil'ev, A. N. (Leningrad State Univ.). Teor. Mat. Fiz.; 12: No. 3, 352-69(Sep 1972). (In Russian).

The 1st and 2nd Legendre transformations of the generating functional of connected Green functions which were introduced previously are considered. For these transformations the equations of motion and the equations of connectedness are written out in terms of variational derivatives. The analysis of the iteration solution of these equations shows that the 1st (resp. the 2nd) Legendre transformation is represented by the sum of one-particle (resp. two-particle) irreducible Feynman graphs. (auth)

59967 LOCAL SATURATION OF COMMUTATOR MATRIX ELEMENTS. Dahmen, Hans D. (Univ., Heidelberg). Springer Tracts Mod. Phys.; 62: 29-36(1972).

From Springer tracts in modern physics conference; Hamburg, Germany (12 Jul 1971). See CONF-710734.

An approach to the systematic construction of local approximation which can be completely characterized in terms of intermediate states is presented. The first order approximation is carried out, the solution has the form of pole structures for the matrix elements of the retarded commutator. The second order approximation is given for the vacuum one-particle matrix element of the commutator. (L.B.S.)

59968 EXTENSION OF WHEELER–FEYNMAN QUANTUM THEORY TO THE RELATIVISTIC DOMAIN. II. EMISSION PROCESSES. Davies, P. C. W. (Cambridge Univ., Eng.). J. Phys., A (London); 5: No. 7, 1025-36(Jul 1972).

In previous work (J. Phys. A. Gen. Phys., 4: 836-45(1971)) from the standpoint of the S matrix it was examined whether inside a light tight box the photon propagator D_F may be replaced by its real part D, without change in the quantum generalization of the classical absorber theory of Wheeler and Feynman. The classical radiation field is examined, some concepts and definitions being clarified. The previous results are used to derive the usual expressions for the real photon processes of conventional quantum electrodynamics. (auth)

59969 SOME REMARKS ON AN EQUIVALENCE THEOREM FOR AN INTERACTING MASSIVE SPIN ONE PARTICLE IN QUANTUM FIELD THEORY. Jenkins, J. D. (Univ. of Durham, Eng.). J. Phys., A (London); 5: No. 7, 1037-42(Jul 1972).

The quantization of a massive spin-one particle field, satisfying the first order system of equations due to Proca (J. Phys. Radium, 7: 347-53(1936)) is summarized. The interaction of such a field with an arbitrary field is then considered. Equivalent theories in terms of vector and antisymmetric second rank tensor spin one fields are then constructed in a simple manner, providing a generalization of an equivalence theorem. In addition, this approach, involving the use of first order systems of equations, allows a simple extension to the case of equivalence theorems for arbitrary integral spin. The nature of this extension is indicated. (auth)

59970 MULTIPLICATIVE RENORMALIZATION GROUP AND THE CRITICAL BEHAVIOR IN $D = 4 - \epsilon$ DIMENSIONS. Di Castro, C. (Univ., Rome). Lett. Nuovo Cim.; 5: No. 1, 69-74(2 Sep 1972).

The renormalization group equations are derived for a theory $(|\psi|^2)^2$ in d dimensions. In particular, a system of bosons interacting via a two-body point potential $\hat{V}\delta(r_1 - r_2)$ above the critical temperature is considered. It is shown how the use of the multiplicative renormalization group can lead to results giving a scheme in which to discuss and compute both the critical behavior and the approach to it. (L.B.S.)

59971 PATHOLOGICAL FEATURES OF SELF-ENERGIES AND LIGHT-CONE SINGULARITIES. van der Merwe, P. du T. (Atomic Energy Board, Pretoria). Lett. Nuovo Cim.; 5: No. 1, 34-6(2 Sep 1972).

A new approach to the self-energy problem is suggested. It is shown in particular, that in the absence of delta-functions or derivatives thereof on the light-cone of the two-particle propagator the divergent terms are eliminated. (L.B.S.)

59972 HAMILTONIAN FORMALISM FOR GENERAL LAGRANGIANS WITH HIGHER-ORDER DERIVATIVES. Kimura, T. (Hiroshima Univ.). Lett. Nuovo Cim.; 5: No. 1, 81-5 (2 Sep 1972).

It is shown that in the case of a Lagrangian system, where the highest derivative of a generalized co-ordinate cannot be expressed in terms of the lower derivatives and the generalized momenta, the correct treatment of constraint equations leads to a consistent Hamiltonian formalism without either employing the equation of motion or rewriting the Lagrangian. (L.B.S.)

59973 AXIAL-VECTOR ANOMALIES AND THE SCALING PROPERTY OF FIELD THEORY. Zee, A. (Rockefeller Univ., New York). Phys. Rev. Lett.; 29: No. 17, 1198-1200(23 Oct 1972).

A proof of the Adler–Bardeen theorem is given with the aid of the Callan–Symanzik equation. (auth)

59974 MODIFIED QUANTIZATION OF THE SPINOR FIELD. Marx, E. (Harry Diamond Labs., Washington, D. C.). Nuovo Cim.; 11B: No. 2, 257-75(11 Oct 1972).

A quantization procedure for the spinor field in an external electromagnetic field that leads to a theory with a fixed number of ‘‘particles’’ is presented. As in relativistic quantum mechanics, a ‘‘particle’’ can be found in a particle state, propagating forward in time, or in an antiparticle state, propagating backward. This way, pair creation and annihilation appear as changes in the mode of propagation. The roles of the creation and annihilation operators are interchanged for the antiparticles, and it is further assumed that the Hamiltonian operator displaces the antiparticle backward in time. This can be carried out systematically if one uses Dirac's many-times formalism and numbered particle operators. Although the dynamical problems are very different from those of the conventional formulation, transition amplitudes for finite times are quite similar. The main difference in the perturbation expansion is the absence of terms with closed fermion loops. It is also found that the vacuum is a stationary state, and a closed single-particle theory for the amplitudes with one ‘‘particle’’ which is a modified Dirac equation is obtained. (auth)

59975 PHYSICAL INTERPRETATION OF HIGHER-DERIVATIVE FIELD THEORIES. Riewe, F.; Green, A. E. S. (Univ. of Florida, Gainesville). J. Math. Phys. (N. Y.); 13: No. 9, 1374-80(Sep 1972).

Polynomial-type field equations are shown to have a realistic physical interpretation in terms of particle form factors, both for classical fields and for ‘‘dipole-regularized’’ quantized fields. Form factors arising from such field equations are found to give a reasonable description of the electromagnetic structure of the proton. (auth)

59976 APPROACH TO THE RADIATIVE CORRECTIONS IN QED IN THE FRAMEWORK OF THE PADE METHOD. Fogli, G. L.; Pellicoro, M. F.; Villani, M. (Univ., Bari, Italy). Nuovo Cim.; 11A: No. 1, 153-77(1 Sep 1972).

It is shown how the difficulties of perturbation theory, when radiative corrections are considered, can be overcome through an extension of the Padê method to the series with divergent terms. The improvement achieved by the method is discussed first when the radiative corrections contribute only through an infinite phase factor, as in Coulomb potential scattering. Then the Bloch–Nordsieck model is considered, where an appropriate computational scheme for the radiative corrections due to real and virtual photons is worked out; the scheme allows one to obtain good approximations to the solution of the model, starting from the knowledge of a finite number of perturbative terms. Finally, the method is then applied to the relativistic scattering of electrons by an external field. (7 figures) (auth)

59977 PERTURBATION SERIES FOR DUAL AMPLITUDES. Rivers, R. J. (Imperial Coll. of Science and Tech., London). Nuovo Cim.; 11A: No. 1, 178-84(1 Sep 1972).

The nature of the perturbation expansion for dual amplitudes that are suggested by an infinite-component field theory and a parton–quark (or gluon–quark) field theory is examined. (auth)

59978 UNITARIZATION OF $SU_3 \times SU_3$ FIELD ALGEBRA AMPLITUDES. Banyai, L.; Mezincescu, L. (Inst. of Physics, Bucharest). Nuovo Cim.; 11A: No. 1, 23-36(1 Sep 1972).

Vector and axial vector fields with continuously distributed masses are used in the effective chiral $SU_3 \times SU_3$ Lagrangian formalism to impose some unitarity constraints on tree graph amplitudes. Good numerical results are obtained for some masses and widths. (auth)

59979 QUANTUM MECHANICS AND FIELD THEORY ON MULTIPLY CONNECTED AND ON HOMOGENEOUS SPACES. Dowker, J. S. (Univ. of Manchester, Eng.). J. Phys., A (London); 5: No. 7, 936-43(Jul 1972).

The basic framework for discussing quantum mechanics on multiply connected spaces is presented using the covering space concept. The theorem of Laidlaw and DeWitt (Phys. Rev. D3; 1375-8(1971)) is rederived and extended to the case of field theory. It is pointed out that chiral dynamics is similar to Skyrme's nonlinear theory (Proc. Roy. Soc., A247: 260-78(1958), A252: 236-45(1959), A260: 127-38(1961)) and forms another example of Finkelstein's kink idea (J. Math. Phys. 7: 1218-25(1966)). The possible existence of ‘‘geons’’ is raised, and the fact that the pion manifold may be any one of the Clifford–Klein constant curvature space-forms, rather than just the whole three-sphere, is suggested. The related formalism for quantum mechanics on homogeneous spaces is given in general terms. (auth)

59980 CONTRACTIONS OF REPRESENTATIONS OF DE SITTER GROUPS. Mickelsson, J.; Niederle, J. (International Atomic Energy Agency, Vienna). Commun. Math. Phys.; 27: No. 3, 167-80(1972).

In order to construct the quantum field theory in a curved space with no ‘‘old’’ infinities as the curvature tends to zero, the problem of contraction of representations of the corresponding group of motions is studied. The definitions of contraction of a local group and of its representations are given in a coordinate-free manner. The contraction of the principal continuous series of the de Sitter groups $SO_0(n,1)$ to positive mass representations of both the Euclidean and Poincaré groups is carried out in detail. It is shown that all positive mass continuous unitarity irreducible representations of the resulting groups can be obtained by this method. For the Poincaré groups the contraction procedure yields reducible representations which decompose into two nonequivalent irreducible representations. (auth)

59981 FIELD ALGEBRA AND ITS POSITIVE LINEAR FUNCTIONALS. Wyss, W. (Univ. of Colorado, Boulder). Commun. Math. Phys.; 27: No. 3, 223-34(1972).

It is shown that positive linear functionals on the field algebra are necessarily continuous and can be represented by conical measures. Furthermore extension theorems for continuous linear functionals, defined on a subspace of the field algebra, to positive linear functionals are discussed. (auth)

59982 ASYMPTOTIC BEHAVIOR OF WIGHTMAN FUNCTIONS IN SPACE-LIKE DIRECTIONS. Herbst, Ira (Univ. of Michigan, Ann Arbor). Commun. Math. Phys.; 27: No. 3, 235-9 (1972).

The asymptotic behavior of the truncated vacuum expectation value of a product of N (unbounded) quasilocal operators, $F(x) = \langle Q_1(x_1) \ldots Q_N(x_N)\rangle_T$, is investigated for some of the separations space-like. It is shown that unless all clusters $\{x_{i_1}, \ldots, x_{i_j}\}$ are partially time-like (or light-like) separated from their complements $\{x_{i_{j+1}}, \ldots, x_{i_N}\}$, F(x) decreases faster than any inverse power of the diameter of the set $\{x_1, \ldots, x_N\}$. (auth)

59983 ADAPTIVE MULTIDIMENSIONAL INTEGRATION TECHNIQUE. Lautrup, B. (European Organization for Nuclear Research, Geneva). pp 1.58-1.82 of Advanced Computing Methods in Theoretical Physics. Vol. 1. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655—(Vol.1).

A procedure for the automatic (adaptive) evaluation of the integrals occurring in quantum electrodynamics calculations involving higher order radiative corrections is considered. The basic principles of the method are presented. The integration region (the unit hypercube) is subdivided into a set of subvolumes, the contribution to the integral and its variance being estimated for each subvolume by a random sampling of the integrand (Monte Carlo integration). An improved subdivision of the unit intervals is calculated using these variances and integrals; the procedure is reiterated. (France)

59984 SERIES WITH DIVERGENT TERMS AND THE PADE METHOD. Villani, M. (Univ., Bari, Italy). pp 2.73-2.87 of Advanced Computing Methods in Theoretical Physics. Vol. 1. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655--(Vol.1).

The perturbation series expansions used in quantum field theories are frequently power series with divergent terms. The difficulties associated with such series are overcome using an appropriate extension of the Pade method. Stieljes series with divergent moments, Born series with divergent terms are considered. The method may be used to calculate scattering lengths (the peratization being introduced), the total scattering amplitude, and the quantum electrodynamics radiative corrections. (France)

59985 ADVANCED COMPUTING METHODS IN THEORETICAL PHYSICS. VOLUME 2. Second Colloquium Held in Marseille, France, June 21, 1971. Marseille, France; Centre National de la Recherche Scientifique ([1971]). vp. (In French and English). (CONF-710655--(Vol.2)).

The conference included six papers. Separate abstracts were prepared for each paper. (J.F.P.)

For abstracts of individual papers see: 59790, 59791, 59986–59988, and 60515.

59986 ALGEBRAIC COMPUTATION TECHNIQUES IN QUANTUM ELECTRODYNAMICS. Brodsky, S. J. (Stanford Linear Accelerator Center, Calif.). pp 4.1-4.27 of Advanced Computing Methods in Theoretical Physics. Vol. 2. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655--(Vol.2).

The renormalization theory is outlined. A general systematic algebraic approach to the automatic reduction of multiloop Feynman diagrams into parametric form is discussed; numerical integrations are envisaged. The applications of these techniques to fourth and sixth order calculations of the lepton vertex are described; the results are compared with those obtained experimentally. New computation techniques applicable to quantum electrodynamics are presented. (France)

59987 SUBTRACTED GENERALIZED POLYLOGARITHMS AND THE SINAC PROGRAM. Peterman, A. (European Organization for Nuclear Research, Geneva). pp 4.62-4.75 of Advanced Computing Methods in Theoretical Physics. Vol. 2. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655--(Vol.2).

The definition of the subtracted generalized polylogarithms is given together with their properties which are used in the Standard Integrals Analytic Calculation program (SINAC). A short account is given on how this program is used in analytic calculations of parametric integrals in quantum electrodynamics. (France)

59988 DISPERSIVE CALCULATION OF DIAGRAMS WITH ARBITRARILY MANY EXTERNAL LINES. Veltman, M. (State Univ., Utrecht). pp 4.115-4.131 of Advanced Computing Methods in Theoretical Physics. Vol. 2. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655--(Vol.2).

A dispersion method for perturbation theory calculations in quantum electrodynamics is presented. The method can be used for diagrams with many arbitrary external lines. (France)

Gravitation and General Relativity

59989 MACH'S PRINCIPLE AND A NEW GAUGE FREEDOM IN BRANS–DICKE THEORY. O'Hanlon, J. (New Brunswick Univ., Fredericton, Can.). J. Phys., A (London); 5: No. 6, 803-11(Jun 1972).

The relation between Mach's principle and the Brans-Dicke scalar-tensor theory of gravitation is discussed. A converse formulation is proposed. It is shown that the geometry of space-time determines the mass-energy content only up to a position-dependent gauge transformation. This is interpreted as a scale change in the unit of mass which preserves the conservation laws. For arbitrary values of the scalar field coupling constant ω the theory is invariant only under a restricted group of gauge transformations. Complete invariance applies in the case $\omega = 0$. Furthermore it is shown that whenever the curvature scalar R vanishes the theory can be transformed into the usual form of Einstein's general relativity. Equivalence classes of solutions are defined which have the same geometry and lead to the same geodesic motion for test particles. Examples are constructed for the case of static spherical symmetry and for uniform cosmology which exhibit these properties. Some further consequences are discussed. (auth)

59990 SOME EFFECTS CONNECTED WITH EINSTEIN'S PRINCIPLE OF EQUIVALENCE. Janossy, L. (Central Research Inst. for Physics, Budapest); Treder, H.-J. Acta Phys. Acad. Sci. Hung.; 31: No. 4, 367-74(1972).

The role of the $\frac{1}{2} g_{ik} R$ term appearing in Einstein's gravitational equation is discussed. This term did not appear in Einstein's original formulation as given in 1915; however, as Einstein already noticed without this term the gravitational equations lead to a hydrostatic pressure inside matter. Later he introduced this term arguing on considerations on symmetry connected with the principle of equivalence. It is shown that this type of hydrostatic pressure would appreciably modify the configuration of atoms. Therefore it follows from the observation of atoms that the gravitational equations either obey exactly the principle of equivalence, or if there is a deviation from this principle, the deviation must be very small. (auth)

59991 ENERGY OF GRAVITATIONAL SHOCK WAVES. Robinson, David C. (King's Coll. London); Winicour, Jeffrey. J. Math. Phys. (N. Y); 13: No. 9, 1435-41(Sep 1972).

A model of a gravitational shock wave is developed using the null hypersurface approach to the initial value problem. Interior to the shock front is a flat Minkowski region. This is joined to a shear-free but curved exterior. The geometric properties of the shock front determine the physical properties of the wave. The gravitational energy measured at null infinity is a functional of the 2-geometry of the shock front. The positive energy conjecture reduces to a simple statement concerning the geometry of 2-surfaces. Explicit numerical calculations carried out for various 2-surfaces have led to positive energy. However, no inequality is known to show that the energy is positive for all 2-surfaces. (auth)

59992 FULLY RELATIVISTIC TREATMENT OF THE BREMSSTRAHLUNG RADIATION FROM A CHARGE FALLING IN A STRONG GRAVITATIONAL FIELD. Ruffini, R. (Princeton Univ., N. J.). Phys. Lett.; 41B: No. 3, 334-8(2 Oct 1972).

The details of the spectral distribution of the radiation emitted by a particle freely falling in a gravitational field are given in the case of the most general static asymptotically flat solution with regular horizon. No contradiction exists with the principle of equivalence. A clear enhancement of high multipoles is shown to exist. (auth)

59993 SOURCES FOR KERR TYPE SPACE-TIMES IN GENERAL RELATIVITY. Marder, L. (Univ. of Southampton, Eng.). J. Phys., A (London); 5: No. 5, 605-7(May 1972).

The source of a Kerr space-time is generally assumed to be reducible to a disc, although the singularity in the solution is in the form of a ring. This is because the maximally-extended exterior manifold is multiply-connected, being formed by two sheets joined through the ring. However, it is possible, in principle, to construct "minimal" sources (reducible to the singularity) for space-times with such topology. This is illustrated in the Kerr case with zero mass constant, and some possibly general features are indicated. (auth)

59994 THEOREM ON CONFORMASTAT METRIC FORMS IN GENERAL RELATIVITY. Massa, E. (Univ., Genoa). Lett. Nuovo Cim.; 5: No. 3, 245-8(16 Sep 1972).

The theorem is proven that every conformastat metric form of a solution of the vacuum field equations $R_{\alpha\beta} = 0$ is spherically symmetric. (J.F.P.)

59995 GRAVITATIONAL RADIATION. III. DETECTORS OF GRAVITATIONAL RADIATION. Kuchowicz, B. (Univ., Warsaw). Urania (Krakow); 43: 7-17(1972). (In Polish).

The main physical principles which form the basis for the detection of gravitational radiation are outlined. It is emphasized that it is rather impossible to detect individual gravitons (quanta of the gravitational field), and that a relatively easier way is to search for waves. All detectors of gravitational waves are based on the idea that gravitational waves which are passing through a region of space are the reason for periodic changes of space curvature; these changes are observed as the changes in local gravity. The efficiency of a detector of gravitational waves increases with its mass; those detectors which are applied now have a mass of the order of one to several tons. There is given a description of Weber's detectors for quadrupole transverse gravitational waves. The eigen frequency of oscillations of these cylindrical detectors should be in the range of the most probable frequencies which are hoped to exist in the spectra of gravitational radiation radiated in the collapse, etc. A peculiar type of detector, with an eigen frequency of 1660 Hz, is described in detail. Other possible types are mentioned. (auth) (NSA of Poland)

59996 GRAVITATIONAL EMISSION IN THE SCALAR–TENSOR THEORY OF GRAVITATION. Gurevich, L. E.; Dynkin, S. D. (Ioffe Inst. of Physics and Tech., Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 2, 369-74(Aug 1972). (In Russian).

The emission of scalar gravitational waves in the scalar-tensor theory of gravitation is considered. It is shown that under certain conditions it may exceed the ordinary tensor emission by several orders of magnitude; in particular the turbulence which is assumed to have existed in the initial stages of the expanding universe, should have resulted, in a broad range of dimensions, in scalar emission which considerably exceeded tensor emission. Moreover, in a spherically symmetric collapse (which apparently occurred in supernova flares) in which tensor emission is absent, scalar emission involves an energy loss which is comparable to the mechanical energy of the dispersing envelope of the star. (auth)

59997 GRAVITATIONAL RADIATION FROM CHARGED BLACK HOLES. Basano, L.; Morro, A. (Univ., Genoa). Lett. Nuovo Cim.; 5: No. 3, 266-8(16 Sep 1972).

It is shown that the efficiency for the conversion of mass into gravitational radiation in the collision and coalescence of two black holes can be appreciably higher than that given previously if the colliding black holes are charged. (J.F.P.)

59998 GENERALIZATION OF THE TAUB–KAZNER COSMOLOGICAL METRIC IN THE SCALAR–TENSOR GRAVITATION THEORY. Ruban, V. A. (Nuclear Physics Inst., Leningrad); Finkelstein, A. M. Lett. Nuovo Cim.; 5: No. 3, 289-93(16 Sep 1972).

It is found that the sourceless scalar field modifies essentially the nature of the initial singularity in the anisotropic cosmology. Therefore the extremely small secular variation of the gravitational constant, allowed by modern observations, must principally change the dynamics of the universe expansion at its early stages. (J.F.P.)

59999 ENERGY EMITTED BY AN ARBITRARY MATERIAL SYSTEM. Silenko, P. N. (Moscow Regional Teachers Coll.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 3, 48-51(1971). (In Russian).

On the basis of an asymptotic solution obtained by R. Sachs for a radiating system, deprived of symmetry, a solution to Einstein field equations was investigated for the case of an arbitrary material system. With the aid of a tetrad formalism of the gravitational field an expression was found for the energy and momentum of the system. (tr-auth)

60000 TIME SYMMETRIC INITIAL VALUE PROBLEM FOR BLACK HOLES. Gibbons, G. W. (Cambridge Univ., Eng.). Commun. Math. Phys.; 27: No. 2, 87-102(1972).

The time symmetric initial value problem for black holes is discussed. It is shown that if a solution contains marginally trapped surfaces these correspond to minimal surfaces lying inside the black holes. Such minimal surfaces must have spherical topology. These minimal surfaces are used to obtain lower bounds for the areas of event horizons and upper bounds for the efficiency for radiating gravitational radiation. It is shown that moving black holes closer together reduces the energy available and that a single initially distorted black hole (perhaps formed just after a very asymmetric collapse) cannot radiate more than 65% of its rest mass away. "Wormholes" are also briefly discussed. (auth)

60001 NON-EXISTENCE OF AXIALLY SYMMETRIC MASSIVE SCALAR FIELDS. Roy, A. R.; Rao, J. R. (Indian Inst. of Tech., Kharagpur). Commun. Math. Phys.; 27: No. 2, 162-6(1972).

It has been observed that for the axially symmetric Einstein–Rosen metric, the stress-tensor of a scalar meson field associated with meson of rest mass μ cannot be the source term for generating gravitation. The above result also holds even when this meson field is coupled with an electromagnetic field. (auth)

60002 ON THE EINSTEIN–CARTAN EQUATIONS. II. Trautman, A. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 20: No. 6, 503-6(1972).

It is shown that by covariant exterior differentiation of the equations of the generalized theory of gravity one arrives at a system of relations which hold as an algebraic consequence of the field equations themselves. The Dirac equation in a Riemann–Cartan space-time is written in a manner adapted to the calculus of exterior forms. (auth)

60003 NEUTRINO IN GENERAL RELATIVITY. Madore, J. (Univ., Paris). Lett. Nuovo Cim.; 5: No. 1, 48-50(2 Sep 1972).

It is shown that there is no neutrino field in general relativity that is static and axially symmetric. (L.B.S.)

60004 CLOSED ANISOTROPIC COSMOLOGICAL MODELS. Batakis, Nikos (City Coll., New York); Cohen, Jeffrey M. Ann. Phys. (N. Y.); 73: No. 2, 578-88(Oct 1972).

From observation, it appears that the anisotropy of our universe is small. Because of this, most workers have assumed isotropy during the entire evolution of their cosmological models of our universe. Such models are in accord with observations of the present state of our universe, but do not explain the isotropy. Recently, Misner has suggested that the early universe could have been anisotropic and yet, the present universe, be highly isotropic if the anisotropy damped out sufficiently rapidly during the expansion of our universe. A new exact solution to Einstein's equations is given representing homogeneous nonisotropic cosmological models of a closed universe containing electromagnetic and scalar fields. This solution reduces to a generalization of Brill's electromagnetic universe when the scalar field vanishes, and Taub-NUT-M space when both these fields vanish. The solutions also satisfy the scalar-tensor equations and represent a universe containing electromagnetic fields and a source-free solution to the scalar-tensor equations representing a closed universe. (auth)

60005 ACTION PRINCIPLE IN GENERAL RELATIVISTIC MAGNETOHYDRODYNAMICS. Maugin, G. A. (Centre de Documentation de l'Armement, Paris). Ann. Inst. Henri Poincare, Sect. A; 16: No. 3, 133-69(1972).

A euclidian discription is given of a variational principle. A generalized Clebsch representation is obtained for the fluid current and the specific enthalpy. This representation is subsequently used to derive a Crocco–Varsonyi theorem, the Euler equations of motion, a "Bernoulli" type theorem, and a form of the action principle in which the Lagrangian of the matter is simply the thermodynamics pressure. (France)

60006 COLLISION BETWEEN AN ELECTROMAGNETIC WAVE AND GRAVITATIONAL WAVE PACKET. Sbytov, Yu. G. Zh. Eksp. Teor. Fiz.; 63: No. 3, 737-44(Sep 1972). (In Russian).

The passage of a test electromagnetic wave through a plane gravitational wave packet is considered. The electromagnetic and gravitational waves move in opposite directions. The behavior of light rays (isotropic geodesic) in the field of a gravitational wave is investigated. It is shown that the gravitational wave focuses the light rays. The nature of this focussing as depending on the type of the functions describing the gravitational field is studied. The Maxwell equations are analyzed on the assumption that the electromagnetic wave has a leading edge and is plane prior to entrance into the gravitational field. The analysis shows that the electromagnetic wave penetrates the wave packet or reaches its back edge at a certain depth corresponding to the point at which focussing of the light rays occurs. Reflection of the electromagnetic wave then occurs and it moves behind the gravitational wave. (auth)

60007 POLARIZATION EFFECTS DURING ELECTRON SCATTERING IN THE GRAVITATIONAL FIELD OF A ROTATING SOURCE. Iskhakov, I. F. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 5, 104-8(1972). (In Russian).

Polarization effects were examined during electron scattering by a gravitational field with a Kerr metric, and also by methods of quantum electrodynamics. A formula for the angle of deviation of a relativistic particle with spin ½ was obtained for such a field. (tr-auth)

60008 CONSERVATION LAWS FOR A SYSTEM OF CHARGED, MAGNETIC ROTATING BODIES IN THE GENERAL THEORY OF RELATIVITY. Ryabushko, A. P. (Belorussian Inst. of Mechanized Farming, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 2, 104-13(1972). (In Russian).

A system of n spherically symmetrical bodies of the astronomical type was considered. Each body possessed simultaneously an electric charge, an alternating magnetic field of the dipole type, and an inherent rotation. Post–Newtonian equations of translational motion for a given body of this system were brought to the LaGrange form. Ten integrals of motion were obtained for the system, which were generalized known integrals of Newtonian motion. There were also found n integrals of post-Newtonian equations for rotatory motion. It followed that magnetic field changes involved specific changes in the intrinsic rotation of a body. (tr-auth)

60009 METRIC-SPACE FORMULATION OF NEWTONIAN FIELDS. Kirkwood, R. L. Int. J. Theor. Phys.; 6: No. 2, 133-53(Aug 1972).

In the usual curved-space description of gravity, a class of fields is defined which correspond to the fields of Newtonian gravitational theory. Using these fields, the field equations of Newtonian theory are formulated in a four-dimensional metric space. The equations are then modified so that they transform properly under the Lorentz transformation and so that their weak-field approximation is closely analogous to the equations of classical electrodynamics. The resulting equations lead to Newtonian theory in the nonrelativistic limit, and they lead rigorously to the Schwarzschild field and to the known relativistic corrections associated with it. Finally, these field equations are compared with Einstein's field equations. (auth)

60010 SOME PROPERTIES OF HIGHER SPIN REST-MASS ZERO FIELDS IN GENERAL RELATIVITY. Bell, P.; Szekeres, P. (Univ. of Adelaide). Int. J. Theor. Phys.; 6: No. 2, 111-21 (Aug 1972).

The propagation of a zero rest-mass test field of arbitrary spin $s > 1$ through curved space-time is found to be subject to strong constraints. A null test field is shown to be possible only in a restricted class of spaces previously introduced by Kundt and Thompson (1962). The result is in fact a simultaneous generalization of the theorems of Robinson (1961) and of Goldberg and Sachs (1962). For test fields of spin-2 in vacuum spaces, solutions of the propagation equation are restricted, save in a few exceptional cases, to constant multiples of the Weyl spinor. The exceptional cases are discussed and appear to be physically uninteresting. (auth)

60011 ZEEMAN-ORDER TOPOLOGY ON MINKOWSKI SPACE. Whiston, G. S. (Univ., Naples). Int. J. Theor. Phys.; 6: No. 1, 75-6(Aug 1972).

The order topology on Minkowski space generated by Zeeman's causal order is an elementary example of a topology whose autohomeomorphism group is a Poincaré dilation group. (auth)

60012 ASSOCIATIVE AND NON-ASSOCIATIVE AUTOMORPHISMS OF NEWTONIAN SPACE–TIME. Whiston, G. S. (Univ., Naples). Int. J. Theor. Phys.; 6: No. 2, 79-103(Aug 1972).

An algebraic study of the transformations $(x,t) \rightarrow (R \cdot X + \Sigma_{i=0}^{m} A_i t^i/i, t + t)$ of Newtonian space-time onto itself is presented. The study is carried out within the framework of Eilenberg and Maclane's co-homology theory of group prolongations, a generalization of the theory of group extensions (Eilenberg & Maclane, Duke Mathematical J., 14: 435(1947), Annals of Mathematics, 48; (1) 51, 48; (2) 327, 50; 736 (1947)). The "loops" or nonassociative groups involving "m" from 0 to 5 are placed in classes of decreasing associativity described in the text. The physical applications of the cup-product of co-chains and the vector bundle structure of Newtonian space-time are discussed. (auth)

60013 GRAVITATIONAL SCATTERING OF TWO- AND FOUR-COMPONENT NEUTRINOS. SOME REMARKS IN THE ONE-GRAVITON-EXCHANGE APPROXIMATION. Boccaletti, D.; de Sabbata, V.; Fortini, P.; Gualdi, C. (Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cim.; 11B: No. 2, 289-300 (11 Oct 1972).

The gravitational scattering of neutrinos is considered in the one-graviton-exchange approximation. In this scheme it is found that two- and four-component neutrinos are scattered in the same amount by bosons and in the small-angle limit have the same cross sections as photons. Only neutrino-neutrino scattering gives two slightly different cross sections for the two- and the four-component cases. (auth)

60014 GAUGE GROUPS OF LINEAR CONSERVATIVE GRAVITATIONAL THEORIES. Quale, A. (Univ. of Oslo). Nuovo Cim.; 11B: No. 2, 313-38(11 Oct 1972).

A certain class of Lorentz-covariant linear tensor theories of gravitation, previously investigated by Weyl, with particular emphasis on the gauge groups admitted by these theories is discussed. Weyl's main result—i.e., that essentially only two physically distinct theories of this kind exist, one of which is linearized general relativity—is analyzed in some detail, and the structural differences between these two theories are described. It is found that the two theories are physically equivalent when the matter sources of the gravitational field have a traceless energy-momentum tensor, but otherwise remain distinct. It is shown that the non-Einsteinian theory found by Weyl, together with a certain auxiliary constraint, is equivalent to the linearized weak-field limit of the scalar-tensor theory of gravitation proposed by Brans and Dicke. (auth)

60015 ELECTROMAGNETIC INTERPRETATION OF THE KERR–VAIDYA METRIC. Goodinson, P. A. (Queen Elizabeth Coll., London). Int. J. Theor. Phys.; 6: No. 1, 47-51(Aug 1972).

It is shown that at large distances from a rotating mass, the radiation may be associated with an Einstein–Maxwell null field with a non-zero null current. (auth)

60016 NEW COORDINATE CONDITION, AND ELEMENTARY FLATNESS, FOR AXIALLY SYMMETRIC INTERIOR SOLUTIONS IN GENERAL RELATIVITY. Rawson-Harris, D. (Queen Elizabeth Coll., London). Int. J. Theor. Phys.; 6: No. 1, 53-9(Aug 1972).

Two general results for stationary axially symmetric interior solutions of the Einstein or Einstein–Maxwell equations in cylindrical coordinates are derived. Firstly, a coordinate condition for interior solutions is proposed, corresponding to the Weyl coordinate condition used in the exterior. Secondly, it is shown that elementary flatness in the interior is always ensured by realistic boundary conditions and matter tensors, given elementary flatness in the exterior metric. A physical discussion of the results is given, particularly in reference to solutions which have singular struts in them. (auth)

60017 THEORY OF RELATIVITY. Second Edition. Moeller, C. International Series of Monographs on Physics. Oxford; Clarendon Press (1972). 569p. £13.00.

The topics covered are a historical survey of special relativity, relativistic kinematics and mechanics, tensor calculus for the four-dimensional formulation of relativity theory, electrodynamics in vacuum, general closed systems, mechanics of elastic continua, field theory, nonclosed systems, electrodynamics in dielectric and paramagnetic substances, and thermodynamics. Also treated are the foundations of general relativity theory, permanent gravitational fields in tensor calculus in general Riemannian space, the influence of gravitational fields on physical phenomena, the fundamental laws of gravitation in general relativity theory, experimental verification of general relativity, and cosmological problems. (J.F.P.)

60018 SEARCH FOR GRAVITATIONAL RADIATION OF EXTRATERRESTRIAL ORIGIN. Braginskii, V. B.; Manukin, A. B.; Popov, E. I.; Rudenko, V. N.; Khorev, A. A. (Moscow State Univ.). JETP Lett., (USSR) (Engl. Transl.); 16: No. 3, 108-12 (5 Aug 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 3, 157-61(5 Aug 1972).

The results of the first series of measurements performed with two gravitational antennas with the aim of observing simultaneous responses produced by gravitational radiation from extraterrestrial sources against the background of Brownian oscillations are presented. The validity of the hypotheses that the measured absolute rms value of the oscillation amplitude corresponds to the calculated σ_{Brown} and that the oscillation amplitude has a Rayleigh distribution with a variance calculated beforehand from known f_{quad}, m, and T were verified. Relatively rare bursts of oscillations of patently nonthermal origin were observed in both antennas. The decrease in the number of coincidences following the introduction of delay in one of the channels and the anisotropy of the distribution of the coincidences in sidereal time are significant arguments in favor of the correlated bursts in Wever's experiments. The absence of coinciding bursts above the $3\sigma_{\text{Brown}}$ level in the experimental scheme does not contradict the astrophysical estimates. (J.F.P.)

60019 CLASS OF SOLUTIONS OF EINSTEIN'S EQUATIONS WHICH ADMIT A 3-PARAMETER GROUP OF ISOMETRIES. Foyster, J. M.; McIntosh, C. B. G. (Monash Univ., Clayton, Australia). Commun. Math. Phys.; 27: No. 3, 241-6(1972).

The Plebański and Stachel and Goenner and Stachel lists of metrics, which are solutions of Einstein's field equations, have two double eigenvalues and admit 3-parameter groups of isometries with 2-dimensional spacelike orbits are completed by the addition of metrics which result from the use of a more general metric form. (auth)

Scattering Theory

Refer also to abstracts 59964, 59965, and 60277.

60020 PATH INTEGRAL FOR A THREE BODY PROBLEM. Khandekar, D. C.; Lawande, S. V. (Bhabha Atomic Research Centre, Bombay). J. Phys., A (London); 5: No. 6, 812-19(Jun 1972).

A one dimensional three body problem is treated by the path integral approach of Feynman (1948). When expressed in suitable coordinates, it is possible to extract the symmetry from the path integral of the problem. The resulting propagator is evaluated in a closed analytical form. (auth)

60021 APPROXIMATION TECHNIQUE FOR SOLVING MULTIPARTICLE AND BOUND-STATE SCATTERING PROCESSES. Liu, Tsu-huei (Portland State Univ., Oreg.). J. Math. Phys. (N. Y); 13: No. 9, 1419-28(Sep 1972).

A modified version of the Lee model by Bronzan is investigated by the LSZ formalism approach. The existence of $(V\theta)$ bound state in the Bronzan's model is discussed. An iterative technique is applied for solving the tau functions in the $V-2\theta$ sector. Each term in the series preserves $(V\theta)$ bound state properties, analytic structure, and symmetry properties of the tau function. The S-matrix elements for both nonbound-state and $(V\theta)$ bound state scattering processes in the $V-2\theta$ sector are obtained. Comparison of the result obtained by the iterative expansion method with that obtained by Bronzan's variational principle method is made. (auth)

60022 CONSTRUCTION OF THE PHYSICAL STATES IN THE SHAPIRO–VIRASORO MODEL. D'Adda, A. (Istituto Nazionale di Fisica Nucleare, Turin); D'Auria, R.; Sciuto, S. Lett. Nuovo Cim.; 5: No. 2, 144-6(9 Sep 1972).

Some comments are made about the spectrum of the physical states in the Shapiro-Virasoro model, with particular attention to their construction using the Del Guidice-Di Vecchia-Fubini states. An explicit procedure is given in order to construct the physical states coupled to n tachyons. (L.B.S.)

60023 ANALYTICITY OF PARTIAL WAVE SCATTERING AMPLITUDES AND CONFORMAL MAPPING METHODS. Choudhary, A. R.; Jones, R. B. (Queen Mary Coll., London). J. Phys., A (London); 5: No. 7, 981-1003(Jul 1972).

The problem of finding and calculating numerically a conformal mapping which simultaneously uniformizes several branch points in energy of a partial wave scattering amplitude is studied. Arguing from a potential scattering model, a general prescription is given for the construction of such conformal mappings in terms of automorphic forms. The automorphic forms are defined with respect to a group each of whose generators arises from one of the cuts in the energy plane of the scattering amplitude. The automorphic forms are calculated numerically from their Fourier series. The method is illustrated in detail for a relativistic single particle exchange model. Finally it is shown how the conformal mapping leads to simple representations of the analytic properties of the amplitude in terms of the uniformizing variable. (auth)

60024 PATH INTEGRATION OF A THREE BODY PROBLEM. Khandekar, D. C.; Lawande, S. V. (Bhabha Atomic Research Centre, Bombay). J. Phys., A (London); 5: No. 7, L57-9(Jul 1972).

Path integration for a one dimensional three body problem is discussed. This involves essentially the path integration of a Lagrangian in plane polar coordinates with a potential energy term depending on both the radial and angular coordinates. (auth)

60025 PERTURBATION THEORY FOR RESONANCE AND VIRTUAL LEVELS. Manaenkov, S. I. (Moscow State Univ.). Teor. Mat. Fiz.; 12: No. 3, 397-406(Sep 1972). (In Russian).

The Hilbert–Schmidt method is used for constructing the perturbation theory which describes corrections to the energies of the bound, virtual, and resonance state. The corrections to the scattering phase shifts are found. The short-range and Coulomb potentials are considered as perturbations. (auth)

60026 NUMERICAL DETERMINATION OF REGGE POLES IN POTENTIAL SCATTERING. Stern, M. S.; Warburton, A. E. A. (Univ. of Hull, Eng.). J. Phys., A (London); 5: No. 5, 717-25 (May 1972).

Regge poles of local interactions with a $1/r$ singularity at the origin are determined from a polynomial equation which can be solved extremely rapidly on a computer. This equation is found to be particularly suitable for locating the poles at negative energies, but impractical at positive energies. A simple formula is derived for the residue at a pole. (auth)

60027 GROUP-THEORETICAL MEANING OF DUAL TRANSFORMATIONS IN THE SPACE OF COHERENT STATES. Popov, Kh. D.; Stoyanov, D. Ts.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 12: No. 3, 370-83(Sep 1972). (In Russian).

The representation of the SL(2,R) group is obtained which implements dual transformations in the space of coherent states of a five-dimensional oscillator. This representation is applied to the factorization of dual N-point amplitudes of the multiperipherical type. (auth)

60028 STRENGTH OF COMPLEX SINGULARITIES IN A MASS VARIABLE. Craigie, N. S.; Kraemmer, A. B.; Rothe, K. D. (Univ., Heidelberg). Nuovo Cim.; 11A: No. 3, 665-75 (1 Oct 1972).

The analyticity of a four-point function is studied, basing the arguments on the box diagram, with special emphasis on the analytic properties in an external mass variable. Both the scattering and the decay regions are considered. By combining explicit integration with the standard methods based on the Landau equations, the position and strength of the box graph singularities are given. This enables the relative strength of the complex and normal-threshold cuts to be estimated for more general amplitudes. The physical implications are briefly discussed. (auth)

60029 SUMMING THE PARTIAL-WAVE SERIES FOR SPIN-0–SPIN-0 AND SPIN-$\frac{1}{2}$–SPIN-0 AMPLITUDES. Abbe, W. J. (Univ. of Georgia, Athens). Nuovo Cim.; 11A: No. 3, 687-700(1 Oct 1972).

After briefly reviewing the literature on Regge poles in nuclear resonant reactions, an integrodifferential equation for summing the partial-wave series is cast into the form of a standard integral equation and several methods of solution are suggested, including Fredholm methods, straight iteration and another type of series solution. The solution by straight iteration is shown to be a generalization of previous work by the author. The results are presented for scattering of spin-0 particles from a spin-0 target, and spin-$\frac{1}{2}$ particles from a spin-0 target; they may be useful both for calculating low-energy nuclear resonant reaction amplitudes and for performing high-energy bootstrap calculations. (auth)

60030 SASAKAWA APPROACH TO THREE-PARTICLE SCATTERING. Fuda, M. G. (State Univ. of New York, Buffalo). Nuovo Cim.; 11A: No. 3, 701-15(1 Oct 1972).

An idea introduced by Sasakawa is used to convert the Faddeev equations into integral equations in which the inhomogeneous term contains the amplitudes for inelastic scattering and rearrangement collisions. The kernels are thereby modified and made nonsingular for energies below the three-particle break-up threshold. The equations are derived for a system of three nonidentical spinless particles interacting through central two-particle potentials. An iterative method for solving the modified equations is developed. It is shown how to symmetrize the equations for a system of three identical spinless particles. The equations are written out in detail for the angular-momentum–zero state of three identical spinless particles interacting through an s-wave two-particle force which produces only one two-particle bound state. The lowest-order approximation to the solution of the equations for this simple system is worked out. It is found that this approximation satisfies unitarity for energies below the three-particle break-up threshold. (auth)

60031 ASYMPTOTIC BEHAVIOUR OF DUAL AMPLITUDES WITH MANDELSTAM ANALYTICITY. Gonzales, L.; Hong Tuan, R. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Lett. Nuovo Cim.; 5: No. 1, 1-6(2 Sep 1972).

Some points about the asymptotic behavior of dual amplitudes $M(s,t)$ with Mandelstam analyticity for $|S| \to \infty$ in any direction in the first sheet are discussed. The necessary condition for $M(s,t)$ to have Regge behavior and satisfy fixed-t dispersion relations with a finite number of subtractions is obtained. (L.B.S.)

60032 POTENTIAL HARMONICS IN THE THREE-BODY PROBLEM. Pustovalov, V. V. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 16: No. 2, 316-20(Aug 1972). (In Russian).

It is shown that potential harmonics provide a more quick convergence in the K-harmonics method. In the case of tensor forces the "tree"-type functions for three particles corresponding to potential harmonics are decomposed in angular functions $W^{\nu}_{KLM}(\Omega)$ with quantum numbers K^2, $L = 2$, M, ν and Ω. The potential harmonics can be calculated after symmetrization. This procedure taking into account permutation properties of $W^{\nu}(\Omega)$ turns out to be quite a simple operation. The method of calculating the matrix elements of "realistic" potential in $W^{\nu}(\Omega')$ functions is known. (auth)

60033 TAKING INTO ACCOUNT THE CUTS ON THE BASIS OF THE REGGE COMPLEX POLE MODEL. Zotov, N. P.; Tsarev, V. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 16: No. 2, 406-10(Aug 1972). (In Russian).

The possibility for taking into account the Regge cuts on the basis of the Regge complex pole model and duality is discussed. (auth)

60034 VARIATIONAL PADE METHOD FOR THE DETERMINATION OF BOUND STATES, RESONANCES, AND PHASE SHIFTS. Alabiso, C. (Univ., Parma, Italy); Butera, P.; Prosperi, G. M. pp 2.7-2.33 of Advanced Computing Methods in Theoretical Physics. Vol. 1. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655—(Vol.1).

The problem of the approximate calculation of bound states, resonances and phase shifts in potential scattering theory, using Pade approximants, is discussed. The convergence difficulties are connected with the left hand singularities in the complex z-plane of the partial wave Born terms. In order to overcome these difficulties, the Pade method is applied directly to the diagonal matrix elements of the transition operator (e.g., $T(z,g)$ is applied to $t_l\ (z;k;g)$), the so-called partial wave off-shell scattering amplitude (g is the coupling constant). (France)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

60035 (BNL–17101) SINGLE PARTICLE EXCITATIONS IN SOLID HELIUM. Kitchens, T. A.; Shirane, G.; Minkiewicz, V. J.; Osgood, E. B. (Brookhaven National Lab., Upton, N. Y.). Jul 1972. 8p. (CONF-720833–6). Dep. NTIS.

From thirteenth international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

High-energy high-momentum transfer neutron scattering experiments on the low-density phases of solid helium-4 indicate the existence of single-particle excitations. The characteristics of the neutron groups are found to be isotropic and independent of the crystallographic phase of the solid sample within the accuracy of this exploratory investigation. The scattered neutron groups appear to have the same properties as those from liquid helium-4, thus illustrating that in yet another property this quantum solid is liquid-like. The neutron groups obeying the single-particle dispersion relation are well formed for energies as low as $1\frac{1}{2}$ times the most energetic phonon in the bcc phase. This work appears to be the first observation of single-particle dispersion relation from a solid sample. Reasons for this and the effect of multiphonon scattering are discussed. (auth)

60036 (BNL–17122) DIELECTRIC CONSTANT AND VISCOSITY OF PRESSURIZED ^{3}He–^{4}He SOLUTIONS NEAR THE TRICRITICAL POINT. Lai, C. M. (Brookhaven National Lab., Upton, N. Y. State Univ. of New York, Stony Brook); Kitchens, T. A. (Brookhaven National Lab., Upton, N. Y.). Aug 1972. 11p. (CONF-720833–8). Dep. NTIS.

From thirteenth international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

Measurements of the dielectric constant ϵ and the product of the normal density ρ_n and the viscosity η have been made on ^{3}He–^{4}He solutions at pressures up to the solidus. In this experiment both $\rho_n\eta$, determined from the damping on a vibrating wire, and ϵ, determined by the frequency shift of a tunnel diode oscillator, can be measured simultaneously in both the ^{3}He-rich and the ^{4}He-rich phases below the separation. Data taken for 63.6% to 75.1% ^{3}He for temperatures between 0.45 and 1.2°K are presented. Viscosity and $\rho_n\eta$ results near the tricritical point, and the resulting phase diagram for elevated pressures obtained from the measured dielectric constant are given. (auth)

60037 (COO–3151-10) LOW TEMPERATURE SPECIFIC HEAT OF ^{4}He FILMS IN RESTRICTED GEOMETRIES. Tait, R. H.; Pohl, R. O.; Reppy, J. D. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Aug 1972. 11p. Dep. NTIS.

Padmore [Phys. Rev. Lett., 28, 1512(1972)] proposed a model for long wavelength phonons in zero-dimensional geometry that gave a linear temperature dependence and a constant heat capacity at low temperatures. Heat capacity work was carried out both to evaluate the validity of Padmore's model and to extend to lower temperatures (0.06 to 0.6°K) the ^{4}He film studies. The results are presented and compared with other work. (M.H.R.)

60038 (KFK–1584) CRITICAL HEAT FLUX AND THERMAL QUENCHING OF HELIUM II IN VERY LONG CHANNELS. Krafft, Gerd (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). May 1972. 14p. (CONF-720446–1). Dep. NTIS (U. S. Sales Only).

From Low temperature conference of the European Physical Society; Freudenstadt, Germany (6 Apr 1972).

Heat-transport experiments with superfluid helium in pipes of 15 to 400 cm length and diameters between 0.3 and 1.0 cm show that, in heat-induced counterflow of He II, the critical heat flow density, i.e., the heat flux when superfluidity breaks down and vaporization onset starts, is a function of tube length and bath temperature. It is mainly determined by the amount of superheating required for bubble formation. Experimentally, it is evident that the degree of superheat is dependent on hydrostatic pressure and temperature. (auth)

60039 (LA-DC–72-891) DISSIPATION IN THE FLOWING SATURATED SUPERFLUID FILM. Hoffer, J. K.; Fraser, J. C.; Hammel, E. F.; Campbell, L. J.; Keller, W. E.; Sherman, R. H. (Los Alamos Scientific Lab., N. Mex.). [nd]. 11p. (CONF-720833–3). Dep. NTIS.

From thirteenth international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

The flow of the unsaturated helium-II film through an inverted U-tube connecting two reservoirs of bulk liquid was measured with significantly improved precision over previous work to provide a direct experimental determination of the intrinsic dissipation in the film as a function of velocity and temperature. The apparatus is shown schematically and results are plotted. (M.H.R.)

60040 (LA-DC–72-914) DIRECT MEASUREMENT OF THE DISSIPATION FUNCTION OF THE FLOWING SATURATED He II FILM. Keller, W. E.; Hammel, E. F. (Los Alamos Scientific Lab., N. Mex.). 1971. 10p. (CONF-720833–5). Dep. NTIS.

From thirteenth international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

Experiments to measure the profile of the chemical potential of the saturated liquid He II film as it flows into or out from a cylindrical beaker are described. How the results provide a direct measurement of the dissipation function of the system in quantitative agreement with predictions of the thermal fluctuation model of intrinsic dissipation is shown. (M.H.R.)

60041 (LA-DC–72-922) APPLICATION OF THE FLUCTUATION MODEL OF DISSIPATION TO BEAKER FILM FLOW. Campbell, L. J. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 9p. (CONF-720833–1). Dep. NTIS.

From thirteenth international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

An attempt is made to account for the phenomenon of He II film flow over a gravitational barrier theoretically, starting with the recognition that film flow is a steady-state, irreversible process in which dissipation processes must be included. An equation is written that constitutes a theory capable of predicting the measurable features of film flow. It is semi-phenomenological to the extent that the dissipation model's parameters must be measured rather than calculated from first principles. It promises to correlate a large class of film data. (M.H.R.)

60042 RELAXATION PHENOMENA AT ACCELERATION OF ROTATION OF A SPHERICAL VESSEL WITH HELIUM II AND RELAXATION IN PULSARS. Tsakadze, J. S.; Tsakadze, S. J. (Inst. of Physics, Tbilissi, USSR). Phys. Lett.; 41A: No. 3, 197-9(25 Sep 1972).

Measurements of the rotational speed of the PSR 0833 pulsar in Vela and PSR 0531 in the Crab nebula have shown that after a sudden speed-up of their rotation a considerably long relaxation process is observed. According to Pines [1] it is associated with the neutron star's superfluidity predicted by Migdal [2]. An attempt is made to model these processes observing the relaxation motions of liquid helium after sharp changes in the rotational speed of a spherical vessel filled with superfluid liquid. (auth)

60043 QUANTUM-MECHANICAL DETERMINATION OF THE SUPERFLUID DENSITY. Haug, H.; Weiss, K. (Philips Research Labs., Eindhoven, Netherlands). Phys. Kondens. Mater.; 14: No. 4, 324-35(1972).

The constituting conservation laws for a superfluid are quantum mechanically derived. Using thermodynamic relations the superfluid density is model-independently expressed in terms of reduced-density matrices. The general relation is illustrated for the Bogolyubov model, and for two other approximations for the two-particle reduced-density matrix. The resulting relations between the densities of the super component and of the condensate are discussed. (auth)

60044 TRANSPORT OF ENTROPY BY VORTICES AND THE MODIFICATION OF THE VELOCITY OF SECOND SOUND IN SUPERFLUID HELIUM. Lhuillier, Daniel (Univ., Paris). Compt. Rend., Ser. B; 275: No. 2, 61-4(10 Jul 1972). (In French).

It is suggested that the coupling between heat flux and frictional forces is due to the transport of entropy by superfluid vortices. (auth)

60045 REFLECTION AND TRANSFORMATION OF SOUND WAVES IN SUPERFLUID LIQUID ON A SOLID BOUNDARY. Sanikidze, D. G.; Tkeshelashvili, O. G. (Inst. of Cybernetics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 67: No. 2, 317-20(Aug 1972). (In Russian).

Coefficients of reflection and transformation of the first and second sounds at a solid surface are calculated for pure ^{4}He as well as for ^{3}He–^{4}He superfluid solutions. (auth)

60046 SECOND-SOUND VELOCITY AND SUPERFLUID DENSITY NEAR THE TRICRITICAL POINT IN THE ^{3}He–^{4}He MIXTURES. Ahlers, Guenter; Greywall, Dennis S. (Bell Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 29: No. 13, 849-52(25 Sep 1972).

Second-sound velocity measurements were made in He-II near the tricritical point (T_t, x_t). The corresponding superfluid density along the coexistence curve can be described by $\rho_s/\rho = 2.03\epsilon_t$ ($\epsilon_t \equiv 1 - T/T_t$). This agrees with recent theories. At constant concentration x and near the superfluid transition temperature T_λ, the results are consistent with $\rho_s/\rho \sim k_\lambda\epsilon_\lambda^{2/3}$ ($\epsilon_\lambda \equiv 1 - T/T_\lambda$) which is expected on the basis of universality arguments. The amplitude k_λ becomes small for small $x_t - x$, but does not appear to vanish at x_t. (auth)

60047 PHONON DISPERSION IN LIQUID HELIUM UNDER PRESSURE. Svensson, E. C.; Woods, A. D. B.; Martel, P. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev. Lett.; 29: No. 17, 1148-9(23 Oct 1972).

One-phonon neutron scattering was studied in liquid helium at a pressure of 24 atm in the range of wave-vector transfers $0.2\ \text{Å}^{-1} \leq |Q| \leq 0.7\ \text{Å}^{-1}$ at T = 1.2 K. The results give a value $(6.2 \pm 0.6) \times 10^{37}\ g^{-2}\ cm^{-2}\ sec^2$ for the parameter γ, which characterizes the phonon dispersion. The one-phonon peaks exhibit tails indicating shortened phonon lifetimes at elevated pressures. (auth)

60048 ^{3}He-LIMITED DRIFT OF CHARGE CARRIERS IN SUPERFLUID ^{4}He ($0.3 < T < 1.0$°K). Schwarz, K. W. (Univ. of Chicago). Phys. Rev. A; 6: No. 5, 1947-9(Nov. 1972).

Measurements were made of the mobility of positive and negative charge carriers in ^{4}He, for ^{3}He impurity concentrations ranging from 10 to 1800 ppm and temperatures in the range $0.3 < T < 1.0$°K. The excess inverse mobility $e/\mu - e/\mu_0$ was everywhere found to vary linearly with concentration, as expected. For negative carriers, the data are well explained by a hardsphere scattering model with a collision radius of 21 Å. For positive carriers, the polarization-deficit potential proposed by Bowley and Lekner gives reasonable agreement with experiment, provided a collision radius of 7.0 Å is assumed. (auth)

60049 HYDRODYNAMIC OPERATORS IN ATOMISTIC MODEL THEORIES OF LIQUID ^{4}He. Jackson, H. W. (Ford Motor Co., Dearborn, Mich.). Ann. Phys. (N. Y.); 72: No. 2, 305-22(Aug 1972).

Theories of several different atomistic models of superfluid helium are known to be encompassed by correlated basis function (CBF) formalism. Some of the basic CBF results for liquid ^{4}He are developed in terms of hydrodynamic operators, and cross links are thereby established between atomistic and hydrodynamic descriptions of the system. (auth)

60050 SCATTERING OF PHONONS BY CHARGE CARRIERS IN SUPERFLUID HELIUM: THE ZERO-VELOCITY LIMIT. Schwarz, K. W. (Univ. of Chicago). Phys. Rev. A; 6: No. 5, 1958-66(Nov 1972).

The problem of phonon scattering by charge carriers in superfluid helium is considered, with the aim of interpreting recent measurements of charge-carrier mobilities below 1°K. The calculations are done in the hydrodynamic approximation, and explicitly include the effect of the electrostrictive variations in the fluid surrounding the core structures of the carriers. For the positive carrier, the necessary core properties are calculated, and in particular it is found that the core does not act like a hard sphere. The theoretically predicted phonon-limited mobility for positives is found to be in excellent agreement with experiment, provided a liquid–solid surface energy of order 0.1 erg cm^{-2} for the core is assumed. In the case of the negatives, results are similar to those of previous workers. The mobility of the electron bubble is substantially explained by resonance scattering of phonons, but a significant discrepancy remains which probably arises from the use of the idealized bubble model. The changes in the theoretical mobility curves that can be produced by varying the bubble parameters a_- and V_1 are of the order of this systematic discrepancy, so that the best values of these parameters cannot be determined from the data. Values of a_- less than 15 Å can, however, be ruled out with some confidence. The roton contribution to the scattering is determined by subtracting the phonon part, and turns out to have some unexpected features. For the positives, $e/\mu_+ \cong 1.34 \times 10^{-9}T^{-1/2}e^{-\Delta/kT}$. The temperature dependence of e/μ_- is not as clearly established, but the prefactor lies between T^0 and $T^{-1/2}$. The ratio of e/μ_- to e/μ_+ is found to have a surprisingly small value of about 1.5, perhaps indicating that electrostrictive variations in the fluid surrounding the positive core scatter rotons strongly. No present theory of roton scattering explains the observed features. (auth)

60051 TEMPERATURE DEPENDENCE OF THE SOUND VELOCITY IN LIQUID ^{4}He. Roach, Pat R.; Ketterson, J. B.; Abraham, B. M.; Kuchnir, M. (Argonne National Lab., Ill.). J. Low Temp. Phys.; 9: No. 1-2, 105-8(Oct 1972).

The temperature dependence of the sound velocity was measured in liquid ^{4}He from 0.07 to 0.7 K for frequencies from 12 to 105 MHz. While the data show an approximate T^4 temperature dependence, the frequency ordering of the curves is observed to undergo an inversion at about 0.2 K. Above this temperature it is confirmed that the velocity shift decreases with frequency, while below this temperature it is now found that the velocity shift increases with frequency as predicted by theory. (auth)

60052 FREE BOUNDARY OF He II AND FEYNMAN WAVE FUNCTIONS. Regge, Tullio (Inst. for Advanced Study, Princeton, N. J.). J. Low Temp. Phys.; 9: No. 1-2, 123-33(Oct 1972).

An extension of the standard hydrodynamical equations for superfluid helium at T = 0 is discussed. Its relation with Feynman wave functions and the well-known Gross–Pitaevskii treatment is elucidated. Finally, a discussion of the free boundary of He-II is carried out and the surface tension computed on the basis of a simple approximation scheme. The result is 0.56 dyne/cm against about 0.35 dyne/cm experimental value. (auth)

60053 KINETIC COEFFICIENTS OF A SUPERFLUID FERMI LIQUID. Shumeiko, V. S. (Kharkov State Univ.). Zh. Eksp. Teor. Fiz.; 63: No. 2, 621-33(Aug 1972). (In Russian).

The transfer coefficients entering the two-liquid hydrodynamics equations are calculated for a superfluid Fermi liquid in the Gorkov model. (auth)

60054 EXCITATION SPECTRUM FOR INTERACTING BOSONS HIGH-DENSITY CALCULATIONS. Khanna, K. M.; Phukan, A. N. (Dibrugarh Univ., India). Physica; 60: No. 2, 488-98(Aug 1972).

The energy excitation spectrum for a system of bosons interacting via a two-body potential composed of a hard repulsive core followed by a square well is obtained using the reaction-matrix formalism. The results obtained bear good qualitative agreement with the experimental results for liquid ^{4}He. It is also concluded that the attractive tail introduced in the two-body potential plays an important role in determining the energy-excitation spectrum for the interacting Bose system. (auth)

60055 EFFECT OF EXPLICIT THREE-PARTICLE CORRELATIONS ON THE LIQUID STRUCTURE FUNCTION OF ^{4}He. Woo, Chia-wei; Coldwell, Robert L. (Northwestern Univ., Evanston, Ill.). Phys. Rev. Lett.; 29: No. 16, 1062-4(16 Oct 1972).

The discrepancies that exist between theory and experiment in the ground-state energy and the liquid structure function of He^4 are not insignificant. It is shown via a two-dimensional Monte Carlo calculation that by incorporating explicit three-particle correlation factors into the variational wave function, both the energy and the liquid structure function are improved in the right direction. This suggests that the discrepancies need not be attributed to the choice of the potential. (auth)

60056 TOPICS IN THE THEORY OF LIQUID HELIUM FOUR. Chester, G. V. (Univ. of Sussex, Brighton, Eng.). Rend. Semin. Mat. Fis. Milano; 41: 151-67(1971).

Two different topics in the theory of interacting Bose systems are discussed: the structure of its ground state wave function and the properties of this system in rotation. The emphasis is on strongly interacting systems which are hopefully reasonably realistic models of liquid helium-4. (34 references) (auth)

60057 RESONANCE ABSORPTION OF ELECTROMAGNETIC ENERGY BY IONS ON A VORTEX IN SUPERFLUID HELIUM. Ermakov, Yu. A. (Kazan Physical-Technical Inst., USSR). Zh. Eksp. Teor. Fiz.; 63: No. 2, 616-20(Aug 1972). (In Russian).

The possibility of observing resonant absorption of the energy of an electromagnetic field by ion-vortex complexes in rotating helium is considered theoretically. It is shown that at temperatures $T < 0.5$°K such resonance may occur at frequencies $\sim 10^{12}\ sec^{-1}$. The dependence of the resonance frequency on ion radius, radius of vortex core, and concentration of the superfluid component is deduced. The deviation of the vortex ion spectrum from an equidistant one is estimated. Various possible causes of resonance line broadening are considered: viscosity due to interaction between the ion and vortex excitations, coulomb interaction between ions. Relevant estimates are presented. The absorption coefficient is evaluated. (auth)

60058 ROTATING He II FILM. Van Spronsen, E.; Verbeek, H. J.; De Bruyn Ouboter, R.; Taconis, K. W.; Van Beelen, H. (Rijksuniversiteit, Leiden). Physica; 61: No. 1, 129-45(1 Sep 1972).

Measurements of the He II film thickness in a rotating vessel are reported. The results obtained by using a spinning top are described, showing that contrary to the findings of Little and Atkins (Phys. Rev. Lett., 19: 1224(1967)) the thickness of a film in a rotating system behaves as if the film as a whole participates in the rotation. Similar attempts are described to measure the change in film thickness due to a possible persistent current by using a multiply connected top. No changes in thickness are observed which shows that either no persistent current was created at all or that, in agreement with Keller's results, the superfluid velocity does not affect the film thickness. (auth)

Superconductivity

Refer also to abstracts 59961, 60083, 60394, 60443, and 60466.

60059 (CONF-720833-11) FAST NEUTRON DAMAGE IN SUPERCONDUCTING VANADIUM. Sekula, S. T.; Kernohan, R. H. (Oak Ridge National Lab., Tenn.). Aug 1972. 9p. Dep. NTIS.

From thirteenth international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

A single crystal of vanadium was irradiated at a temperature of 40°C for a series of fast neutron fluences. Isothermal magnetization data at 4.2°K are shown for the sample in the annealed state and after several fast-neutron irradiations. Some ac magnetic permeability data obtained for vanadium using a sinusoidal field with $h_0 = 36$ Oe and frequency $\omega = 350$ Hz are given. Results are discussed. Preliminary comparisons of these data with fast-neutron damage in niobium suggest that flux pinning is greater in vanadium than in niobium for a given dose. (M.H.R.)

60060 (CONF-720833-12) NEUTRON SCATTERING, PHONON SPECTRA, AND SUPERCONDUCTIVITY. Smith, H. G.; Wakabayashi, N.; Nicklow, R. M.; Mihailovich, S. (Oak Ridge National Lab., Tenn.). Aug 1972. 8p. Dep. NTIS.

From thirteenth international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

Anomalous dips in the phonon dispersion curves of NbC and ZrC are shown. Pronounced anomalous behavior is observed in technetium and the dispersion curves for the phonons propagating in the C direction are shown. For comparison similar branches for Zr and Y are included. (M.H.R.)

60061 (COO-3156-52) PARAMAGNETIC CRITICAL STATE: PINNING IN A SERIES OF TYPE II SUPERCONDUCTING ALLOYS. Brand, Richard Arnold (Cornell Univ., Ithaca, N. Y. Materials Science Center). May 1972. Contract AT(11-1)-3156. 155p. Dep. NTIS.

Thesis.

The critical state is studied in a series of high-field, transition-metal (TM) superconducting alloys, specifically to investigate the effects of normal-state paramagnetism. The Ti–Nb and Ti–V alloy systems were chosen so as to provide a range of upper critical fields and paramagnetic effects. Critical-current measurements were chosen because of the simplicity of analyzing the data. The critical force density is $F_p = J_c B/10$ dynes/cm^3, with the critical current J_c in amperes and the internal field B in Oe. A phenomenological mixed-state model is constructed in the limits of large, or small, internal field $b = B/H_{c2}$, by using the $\beta^2 = 0$ limit at low fields ($\varkappa_2^*$, etc.) The critical state is treated within the elastic flux lattice theory of Labusch. The results for the Ti–Nb system over the range investigated, 83 to 32 at. % Nb, and the two high V compositions, 82 and 70 at. % V, were all found to obey the results presented for a dislocation cell-wall pinning model. (auth)

60062 (IS-T-542) SURFACE SUPERCONDUCTIVITY IN NIOBIUM AND NIOBIUM–TANTALUM ALLOYS. Hopkins, John Raymond (Ames Lab., Iowa). Aug 1972. Contract W-7405-eng-82. 125p. Dep. NTIS.

Thesis.

The ratio of H_{c3}, the critical field for the surface sheath, to H_{c2}, the upper critical field for the bulk material, niobium, was measured as a function of temperature and mean free path. At temperatures below $T/T_c = 0.85$, the pure Nb sample shows H_{c3}/H_{c2} values well above 1.695 as predicted by Hu and Korenman for the limit of long electronic mean free path. As the mean free path decreases, there is a regular depression of H_{c3}/H_{c2} toward 1.695. At temperatures above $T/T_c = 0.85$, the values of H_{c3}/H_{c2} appear to approach 1.0 rather than 1.695. According to Hu, this behavior might be explained by a depressed interaction strength near the surface. Calculations from the data show that the changes in the interaction strengths are between 0.1 and 2%. Changes in H_{c3} with frequency and anodization of the sample were determined for pure Nb. (auth)

60063 (LA-DC-72-919) SUPERCONDUCTIVITY OF PROTACTINIUM. Fowler, R. D.; Asprey, L. B.; Lindsay, J. D. G.; White, R. W. (Los Alamos Scientific Lab., N. Mex.). 1972. 9p. (CONF-720833-2). Dep. NTIS.

From 13th international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

Repeated success in the detection of superconducting transitions in tetragonal protactinium has shown that protactinium is indeed a superconducting element as was expected. It is believed that the negative results reported from Harwell are attributable to the fact that the samples were prepared by arc-melting the reduced metal. In every case in which protactinium was arc-melted the face-centered cubic phase was produced which was found not to be superconducting except possibly under pressure. The superconductivity of face-centered-cubic protactinium under pressure may be due to conversion of some of the material to the tetragonal phase by pressure. (M.H.R.)

60064 (LA-DC-72-941) DIRECT EVIDENCE FOR THE COEXISTENCE OF SUPERCONDUCTIVITY AND FERROMAGNETISM. Taylor, R. D.; Decker, W. R.; Erickson, D. J.; Giorgi, A. L.; Matthias, B. T.; Olsen, C. E.; Szklarz, E. G. (Los Alamos Scientific Lab., N. Mex.). 1971. 11p. (CONF-720833-15). Dep. NTIS.

From 13th international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

Results are reported that were obtained using a technique to detect magnetic order in $Ce_{1-x}Gd_xRu_2$, that is not sensitive to the presence of superconductivity. The magnetic hyperfine interaction of ^{57}Fe as observed by the Moessbauer Effect (ME) was used as a magnetic probe of host magnetic spin order. From the ME measurements, ferromagnetism is shown to exist at low temperatures at concentrations near $X = 0.13$. Magnetic susceptibility measurements on the same samples show transitions to superconductivity in all cases. (M.H.R.)

60065 PROPERTIES OF SUPERCONDUCTING POINT CONTACTS. Gubankov, V. N.; Likharev, K. K.; Margolin, N. M. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 4, 819-25(Oct 1972).

Translated from Fiz. Tverd. Tela; 14: No. 4, 953-60(Apr 1972).

An experimental investigation of the static and microwave properties of superconducting point contacts of Sn, Nb, and Nb–Zr alloys is reported and the results are compared with the conditions for contact formation. A physical model which explains the behavior of the contacts is discussed. The conditions for applicability of the model presented by Aslamazov and Larkin are analyzed. The effects of temperature, inductance, and capacitance of the needle, and the presence of several conducting regions on the static and microwave properties of the contacts are treated. It is shown that the most probable reasons for the appearance of contacts with "smearing" of the critical current are the inductance of the superconducting electrons and current fluctuations in the bias circuit; the "jumps" of the voltage and hysteresis phenomena are connected with thermal effects (heating of the contact). The behavior of large contacts is explained by formation and motion of fluxoids in the plane of oscillation, in which the features of the volt–ampere characteristics of the large contacts are related to the various geometries of the transverse cross section and the differences in the conditions for the entrance of fluxoids into the conducting region. (auth)

60066 MAGNETIC CHARACTERISTICS OF SUPERCONDUCTING MERCURY IN CHRYSOTILE ASBESTOS. Bogomolov, V. N.; Krivosheev, V. K. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 4, 1059-60(Oct 1972).

Translated from Fiz. Tverd. Tela; 14: No. 4, 1238-40(Apr 1972).

The superconducting properties of filamentary Hg in ~60 Å channels of chrysotile asbestos were studied in an external magnetic field. Longitudinal and transverse critical magnetic fields were measured as a function of temperature; the ratio of longitudinal to transverse critical field is 1.6 to 1.7 over the entire temperature range. The critical current and filament current density j_c were determined as a function of the external transverse field at 3°K. j_c reaches ~10^3 A/cm^2 in a 13-kOe field, indicating the Hg filaments to be a rigid superconductor of the second kind. (D.L.C.)

60067 SUPERCONDUCTING TERNARY A15 PHASES OF VANADIUM. Roeschel, E.; Raub, Ch. J. Metall; 26: No. 1, 29-34(Jan 1972). (In German).

Measurements of the superconducting transition temperature and metallographic studies were made on alloys of the composition $V_3A–V_3B$ (A,B = Si, Ge, Sn, Al, Ga). In the systems V–Ge–Ga and V–Ge–Al the sharpest increase of the transition temperature (up to 14°K) was observed in heterogeneous Ge-rich alloys. The behavior of the Sn-rich A15 phase deviates from the usual A15 phases. Frequently, an increase of the lattice volume is accompanied by a decrease of the transition temperature. (tr-auth)

60068 INTERNAL FRICTION AND RELATIVE VALUE OF YOUNG'S MODULUS OF NIOBIUM IN NORMAL AND SUPERCONDUCTING STATES. Postnikov, V. S.; Zolotukhin, I. V.; Miloshenko, V. E. Sov. Phys.-Solid State (Engl. Transl.); 14: No. 3, 809-10(Sep 1972).

Translated from Fiz. Tverd. Tela; 14: No. 3, 940-2(Mar 1972).

Measurements of Q^{-1} and of $\Delta E/E$ were made on deformed and annealed Nb of 99.8 and 99.991% purity. At the superconducting transition at 9°K, a Q^{-1} peak was observed whose amplitude was independent of purity but was slightly higher for the deformed samples. Another peak could be observed at <5°K or at 5.8°K for some of the samples. The background of Q^{-1} is lower in the superconducting state than in the normal state. The $\Delta E/E$ measurements on 99.991% pure Nb show a smooth discontinuity at 9°K, below which the change in Young's modulus is more complex. (D.L.C.)

60069 EFFECT OF A STRONG ELECTROMAGNETIC FIELD ON THE SUPERCONDUCTING PROPERTIES OF SEMICONDUCTORS. Elesin, V. F.; Kopaev, Yu. V. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 3, 570-4(Sep 1972).

Translated from Fiz. Tverd. Tela; 14: No. 3, 669-74(Mar 1972).

The effect of state mixing between the bands due to the field of an electromagnetic wave on the superconductivity of the excess electrons and holes is studied using a semiconductor model in which the extrema of the valence and conduction bands lie at $p = 0$. The effect amounts to the existence of a dielectric gap proportional to the amplitude of the field and the matrix element for interband transitions. In this case a superconducting state is possible if the size of this gap is less than the superconducting gap, calculated without considering the mixing. This is the analog of the existence of the exciton insulator phase in a semiconductor if the forbidden band of the latter is less than the exciton binding energy. Because the quasi-Fermi levels of the electrons and holes are simultaneously affected by the dielectric and superconducting gaps, the relation between the superconducting transition temperature and the superconducting gap near $T = 0$ turns out to be different than in the BCS model. It follows from investigations of the Meissner effect in such a system that even at $T = 0$, only a part of the electrons and holes, proportional to the ratio of the superconducting gap to the field-induced gap, participate in superconductivity. In addition, the effect of the field on the spin structure of the electron—hole gas is treated, taking account of the Coulomb interaction. It is shown that the ground state of these pairs is a triplet while the electron—hole pairing without a field is not affected by the spin structure. (auth)

60070 HIGH VOLTAGE TRANSMISSION ELECTRON MICROSCOPY OF SUPERCONDUCTING METAL-IMPREGNATED POROUS GLASS. Korda, E. J.; Watson, J. H. P.; Geiss, R. H. (Corning Glass Works, New York). Micron; 3: No. 2, 252-4(1972).

High voltage transmission electron microscopy was used to delineate the morphology of lead in impregnated porous glass. The appearance of the lead confirms the granular model for superconducting metal-impregnated porous glass. (auth)

60071 FLUCTUATION VERSUS INHOMOGENEITY BROADENING OF THE SUPERCONDUCTING TRANSITION. Horn, P. M. (Univ. of Rochester, N. Y.). Phys. Lett.; 41A: No. 4, 361-2(9 Oct 1972).

A simple formula is derived for the excess conductivity $\sigma'(T) = \sigma(T) - \sigma_N$ near the transition of a one-dimensional superconductor assuming an arbitrary variation of transition temperatures along the sample. Comparison with experiment indicates that the observed broadening of the resistive transition cannot be easily attributed to sample inhomogeneity. (auth)

60072 SUPERCONDUCTING ION-BEAM-SPUTTERED CHROMIUM-METAL THIN FILMS. Schmidt, P. H. (Bell Telephone Labs., Murray Hill, N. J.); Castellano, R. N.; Barz, H.; (and others). Phys. Lett.; 41A: No. 4, 367-8(9 Oct 1972).

Ion beam-deposited Cr thin films were found to be superconducting at temperatures of up to 1.52°K. Transition temperatures were dependent on the ion specie used for film deposition with lower T_c's obtained for smaller atomic radius gases. (auth)

60073 KOHN ANOMALY IN THE PHONON SPECTRUM OF NIOBIUM. Chopra, V. (Oxford Univ.). J. Low Temp. Phys.; 9: No. 1-2, 1-9(Oct 1972).

Accurate resistivity measurements were carried out on Nb—W and Nb—Ti alloy systems in the normal state in the temperature range 2 to 9 K. A sharp drop occurs in the lattice contribution to the resistivity at a temperature (the kink temperature) which depends on the nature of the alloying impurity and its concentration. A corresponding anomalous behavior of the specific heat, where the straight-line plot of C/T vs. T displays two slopes, has been attributed by some workers to a change in the Debye temperature of niobium at the kink of the resistance, while others believe it to be due to acoustic plasmons which dominate at low temperatures. The resistivity data here provide strong evidence in support of the former view; the Debye variation is expected to be caused by the presence of the Kohn anomaly in the lattice spectra of niobium. (auth)

60074 HALL EFFECT IN THE VORTEX STATE OF DIRTY TYPE-II SUPERCONDUCTORS. Ebisawa, Hiromichi (Tohoku Univ., Sendai). J. Low Temp. Phys.; 9: No. 1-2, 11-31(Oct 1972).

The off-diagonal component of the conductivity tensor of dirty type-II superconductors is calculated in the magnetic field near H_{c2}. Contributions come from both the fluctuation and static parts. The former is the Ginzburg—Landau (GL) term, whose origin is the motion of Cooper pairs, and is obtained to the order of T/ϵ_F as the result of the energy dependence of the density of states near the Fermi surface. The latter is obtained to the order of $\omega_c\tau$. By use of the diagonal component of the conductivity tensor given by Thompson, Takayama, and Ebisawa, the derivative of the Hall angle with respect to H is calculated; it agrees qualitatively with the observed behavior. (auth)

60075 KINETICS OF THE CURRENT-INDUCED PHASE TRANSITION IN TYPE-I SUPERCONDUCTORS. Posada, E.; Rinderer, L. (Univ., Lausanne, Switzerland). J. Low Temp. Phys.; 9: No. 1-2, 33-52(Oct 1972).

An experimental investigation of the kinetics of the destruction of superconductivity by rectangular current pulses was made on cylindrical Sn and In wires of different purities and diameters. The study was based on the observation of the variation of the voltage along the sample during the transition. As shown by Rothen and Bestgen, only the time t_1 between the beginning of the transition and the onset of the intermediate state can be determined with this method. The results show that if the current I is sufficiently larger than the critical current I_c (typically $I \gtrsim 1.15\ I_c$), then both shape of the voltage pulses and the transition times agree well with the predictions of the electromagnetic theory of these authors. The transition is, in that case, controlled by the electromagnetic damping associated with the penetration into the normal material of the magnetic field due to the current. If I is close to I_c, then the transition is much slower than predicted by the theory and seems to be essentially governed by thermal effects, i.e., absorption of latent heat, generation of Joule heat, and heat exchange with the helium bath; a small influence of superheating is observed in indium samples. (auth)

60076 CREEP STRAIN DELAY AT THE SUPERCONDUCTING TRANSITION. Soldatov, V. P.; Startsev, V. I.; Vainblat, T. I.; Danilenko, L. A. (Physico-Technical Inst. of Low Temperatures, Kharkov). Phys. Status Solidi (b); 53: No. 1, 261-7(1 Sep 1972).

The kinetics of the jump-like process of creep strain increase during the crystal transition from the normal to the superconducting state was studied in Pb and In single crystals. It is shown that the crystal transition from the N (normal) to the S (superconducting) state in the creep process is characterized by a certain delay time during which the creep rate remains constant after the transition to the S state. The delay-time dependence on temperature and stress was studied. The delay time decreased exponentially with the increase of stress on the crystal at the normal state and displays a sharp decrease with the lowering of temperature. Results are accounted for on the basis of the model of a thermally activated unpinning of dislocations from obstacles taking into consideration the peculiarities of the model in the low-temperature region. (auth)

60077 INTERMEDIATE-STATE STRUCTURE IN SUPERCONDUCTING FILMS OF INDIUM. Huebener, R. P.; Kampwirth, R. T. (Argonne National Lab., Ill.). Phys. Status Solidi (a); 13: No. 1, 255-63(16 Sep 1972).

The intermediate state structure in type-I superconducting strips of In was studied with a high-resolution magneto-optical method. The strips were about 5 μm thick and 160 μm wide. Both the magnetic structure due to an external magnetic field applied perpendicular to the film and the current-induced intermediate state due to an electrical transport current in zero external field were investigated. The latter experiments were carried out with average current densities of 10^5 to 10^6 A/cm^2. From the results and Landau's nonbranching model, the wall energy parameter $\Delta(1.7°\mathrm{K}) = 0.76\ \mu\mathrm{m}$. The current-induced intermediate state consists of channels of the normal phase growing abruptly from both edges to the center of the strip. The magnetic field in these channels has opposite orientation for the two sides of the strip. The first channel was observed when the magnetic field of the transport current was about three times the critical field at the sample edge. With increasing current the number of normal channels increases, whereas the width and length of the individual channel remain nearly constant. The abrupt growth of each normal channel from the edge to the center of the strip appears to be analogous to the kink instability in magnetohydrodynamics. Simultaneously with the current-induced magnetic structure, a resistive voltage appears in the specimen. (auth)

60078 INTERACTION BETWEEN A VORTEX AND INTERFACE BETWEEN TWO SUPERCONDUCTORS. Mkrtchyan, G. S.; Shakireyanova, F. R.; Shopoval, E. A.; Shmidt, V. V. (Inst. of Solid State Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 2, 667-9(Aug 1972). (In Russian).

The interaction energy between a superconducting vortex and interface of two superconductors is considered in the London approximation as a function of the distance between the vortex and the interface. It is shown that if $\kappa_1 > \kappa_2$ and $\lambda_1 > \lambda_2$, the energy will be a nonmonotonous function of the distance and the vortex becomes fixed at the interface. (auth)

60079 THERMAL CONDUCTIVITY OF THE INTERMEDIATE STATE OF SUPERCONDUCTORS. Galaiko, V. P.; Bezuglyi, E. V. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 63: No. 2, 713-28(Aug 1972). (In Russian).

The thermal conductivity coefficient tensor for electron excitations in normal layers in the intermediate state of a superconductor is calculated by taking into account the special character of the excitation trajectories in a magnetic field caused by Andreev reflection of electrons and holes from the boundaries with superconducting layers. A technique for averaging expressions containing the electron-system Green function over the impurity distribution is developed with aid of variational derivatives of the Green function with respect to the external source field. The thermal conductivity of a normal layer is found to be considerably smaller than that of an infinite normal metal and exhibits characteristic oscillations with variation of the normal-layer thickness. (auth)

60080 MAGNETIC PROPERTIES OF AN INTRINSICALLY STABLE TYPE-II SUPERCONDUCTOR. Onishi, Toshitada; Muira, Kenji (Electrotechnical Lab., Tokyo). Denki Shikensho Iho; 36: No. 5, 397-411(1972).

Measurements and a few qualitative considerations on the stability of the thermal and the magnetic behaviors of flux-flow voltages are presented, using the Pb—In—Sn ternary alloy superconducting wire which exhibits the property $\partial J_c/\partial T > 0$ in a certain range of temperature and magnetic field. It is clarified that in the region of $\partial J_c/\partial T > 0$, no flux jumps are observed for either the magnetic field sweeps or the current sweeps, that the flux flow states are extremely stable against the thermal and the magnetic disturbances, and that a superconducting state can even be recovered by heating the superconducting wire in spite of carrying a transport current fairly larger than the critical currents. In the region of $\partial J_c/\partial T < 0$, however, flux jumps always occur near the critical currents by which the quenchings are often caused, and therefore no stable flux flow states exist. The mechanism of the pinning centers that exhibit the property $\partial J_c/\partial T > 0$ is qualitatively discussed. (auth)

60081 RE-ENTRANT SUPERCONDUCTING-NORMAL PHASE BOUNDARY OF THE KONDO SYSTEM (La,Ce)Al_2. Maple, M. B.; Fertig, W. A.; Mota, A. C.; (and others) (Univ. of California, La Jolla). Solid State Commun.; 11: No. 6, 829-34(15 Sep 1972).

The re-entrant superconducting-normal phase boundary of the (La, Ce)Al_2 system is reported. The pair breaking parameter deduced from the data increases with decreasing temperature as (−ln T) between 0.1 and 3.30°K. This behavior suggests that the Kondo temperature $T_K \lesssim 0.1$°K. No evidence was found for a third transition temperature down to 6 m°K. (auth)

Equipment and Devices

Refer also to abstract 58924.

60082 (UCRL-74119) WINDING TECHNIQUE FOR SUPERCONDUCTING TAPE IN MULTI-AXIS MAGNETS. Harvey, Arthur R. (California Univ., Livermore. Lawrence Livermore Lab.). 30 Aug 1972. 7p. (CONF-720908-1). Dep. NTIS.

From fourth international conference on magnet technology; Upton, NY. (19 Sep 1972).

A superconducting magnet is in use at Lawrence Livermore Laboratory for a plasma confinement experiment. This magnet, weighing 13 tons, is wound in a four-arc configuration with a mean diameter of 1 m, resembling the seam of a baseball. The conductor is copper-stabilized niobium—titanium sustaining a field of 75 kG within the conductor bundle. Magnets of similar configuration with fields approximating 120 kG at the conductor are being contemplated, requiring nonductile superconducting tapes in lieu of the present multifilament conductor. Winding the tapes into complex shapes presents problems heretofore unconfronted. Investigations are now underway. Topics such as conductor lay, types of insulation, conductor splices, and the expected packing fraction are among those discussed. (auth)

60083 AGEING OF THE RESIDUAL SURFACE RESISTANCE OF SUPERCONDUCTING LEAD CAVITIES. Danielsen, M. (Technical Univ., Lyngby, Denmark). Appl. Phys. Lett.; 21: No. 8, 377-9(15 Oct 1972).

Measurements of the residual surface resistance of superconducting lead cavities as a function of time during a period of a month showed an oscillating variation. An explanation of the aging curves is proposed. (auth)

60084 DYNAMO ELECTRIC MACHINES. Lorch, Hugh Olaf (to English Electric Co. Ltd.). British Patent 1,282,412. 19 Jul 1972. Filed 9 Aug 1968.

Reference is made to synchronous machines having a rotor carrying a dc field winding, and particularly to large ac generators. In such machines the total losses in the rotor amount to a heavy capital value, and the machines are often limited in continuous output since an increase in stator output may demand an increase in rotor current beyond the thermal limit. A rotor construction and cooling arrangement is described in which losses are reduced. The rotor has a superconductive dc field winding maintained at very low temperature. An annular shield of good electrically conducting material is mounted on the rotor, extending beyond the ends of the rotor winding, for shielding the winding from ac or suddenly changing magnetic fields which might otherwise be set up by the stator. Various cooling arrangements are described, employing liquid He. (UK)

PHYSICS (NUCLEAR)

60085 PHYSICS. Paris; Centre d'Etude et de Promotion de la Lecture (1971). 544p. (In French).

This dictionary of physics consists of 500 terms and biographies presented in alphabetical order. Nine essential articles are discussed in greater detail (three concerning the atom, high-energy physics, and plasma physics are abstracted separately). (France)

For abstracts of individual sections see: 59586, 59680, and 60286.

Neutron Interactions with Matter

Refer also to abstract 60745.

60086 (BARC–614) PROGRESS REPORT ON NUCLEAR DATA ACTIVITIES IN INDIA. VIII. Balakrishnan, M. (comp.) (Bhabha Atomic Research Centre, Bombay (India)). 1972. 62p. Dep. NTIS (U. S. Sales Only).

The eighth progress report on Nuclear Data Activities in India covers the work done during the year 1971. Short summaries are given for the work done at 15 institutions. (W.D.M.)

60087 (LA-DC–72-651) LASL INTENSE 14-MeV NEUTRON SOURCE. Henderson, Dale B. (Los Alamos Scientific Lab., N. Mex.). 1971. Contract W-7405-eng-36. 10p. (CONF-720631–1). Dep. NTIS.

From Feasibility and need for a high intensity pulsed and steady state fast neutron source conference; Las Vegas, NV. (17 Jun 1972).

At least two independent suggestions have been made to build a 14-MeV neutron source at 10^{14} to 10^{15} neutrons/cm^2-sec for materials damage studies related to fusion power reactors. Greater detail of the LASL suggestion is presented here than in an earlier report. A feasibility study is proposed in which such a 14 MeV source would be thoroughly investigated. (auth)

60088 (ORNL-TM–3989) REPORT TO THE U. S. NUCLEAR DATA COMMITTEE. Perey, F. G. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 16p. Dep. NTIS.

This memo is a collection of brief reports on recent and not yet generally publicized work at ORNL which is of special interest to the USNDC. Included are abstracts of relevant ORNL reports and papers which have been only submitted for publication. The memo covers the period of time since the last USNDC meeting. (auth)

60089 NEUTRON SPECTROSCOPY: COMPARISON WITH INFRARED AND RAMAN SPECTROSCOPY. Trevino, S. F.; Trask, H. J. (Picatinny Arsenal, Dover, N. J.). Progr. Nucl. Energy, Ser. IX; 11: 37-108(1972).

The subject is covered in sections: the interaction of neutrons with matter (lattice dynamics, neutron scattering exposed); experimental techniques (time-of-flight (TOF) spectrometers (choppers, polycrystalline filter monochromators plus chopper TOF systems, phased-chopper TOF spectrometers, rotating and other fixed crystal TOF spectrometers, pseudo statistical and Fourier chopper TOF systems), triple-axis spectrometer); experimental results (polymers (polyethylene, teflon), ionic crystals (sodium nitrite, potassium azide (KN_3), ammonium halides), hydrogen bonded crystals (hydrogen chloride, hydrogen fluoride, ice), molecular crystals, torsional oscillators (hexamethylbenzene, thiourea, crystal hydrates), metal hydrides, liquids (the Gaussian approximation, the "small K" method, coherent scattering)). (UK)

60090 NEUTRON DIFFUSION AS A RANDOM WALK PROBLEM. Karmeshu; Kothari, L. S. (Univ. of Delhi). Amer. J. Phys.; 40: 1264-9(Sep 1972).

The one-dimensional random walk problem has been generalized to allow for absorption at lattice sites, and then this technique has been used to study one velocity neutron diffusion. It is shown that most of the results that are normally obtained by solving the diffusion equation under appropriate boundary conditions can be obtained directly. Various special cases have been considered, including leakage from a finite lattice and neutron-wave propagation in an infinite lattice. (auth)

60091 THEORY OF PULSED-NEUTRON EXPERIMENTS IN POLYCRYSTALLINE MODERATORS. Beauwens, Robert (Univ. Libre, Brussels); Mika, Janusz. Transp. Theory Statist. Phys.; 2: No. 2, 91-108(1972).

The transport-theoretical analysis of pulsed-neutron experiments in polycrystalline moderators is performed in the space of functions square summable over infinite ranges in velocity and space variables. The possibility of the existence of discrete eigenvalues of the transport operator below the minimum collision rate is demonstrated. (auth)

60092 APPLICATIONS OF THE TRANSFER MATRIX METHOD TO ENERGY DEPENDENT TRANSPORT PROBLEMS. Oztunali, Oktay I. New York; New York Univ. (1971). 222p. University Microfilms Order No. 72-21,786.

Thesis.

The transfer matrix method is applied to energy dependent gamma-ray and neutron transport theory problems for multiplying and nonmultiplying media in one-dimensional plane geometry. The scattering processes included in the formulation are for neutron problems fission, inelastic scattering, elastic scattering with anisotropy, and total scattering, and for gamma-ray problems total and compton scatterings. The cross sections considered are experimental cross sections. Numerical solutions in the form of angle, energy and position dependent fluxes are obtained to various problems. Among these problems are finite and infinite media with discrete sources and critical slabs with finite symmetric reflectors. Numerical results obtained are consistent with physical considerations. The transfer matrix method results are compared with the moments method results for gamma-rays and neutrons for point isotropic monoenergetic sources in an infinite water medium. (Diss. Abstr. Int., B)

60093 NEUTRON SCATTERING FROM ONE AND TWO DIMENSIONAL STRUCTURES. Agarwala, Shashi; Goyal, I. C.; Kothari, L. S. (Indian Inst. of Tech., New Delhi). J. Nucl. Energy; 26: No. 8, 409-18(Aug 1972).

The phonon expansion method, which is used to calculate neutron scattering cross section for isotropic solids, breaks down for linear and layer lattices. A procedure for evaluating the scattering cross sections for linear and layer lattices are discussed. Results for graphite (a 2-dimensional lattice) are compared with the available experimental results and with one-phonon scattering cross section calculated by using Krumhansi—Brooks model of lattice vibrations. (auth)

60094 GENERALIZED SYNTHETIC KERNEL FOR NEUTRON SLOWING DOWN. Yamamura, Y.; Sekiya, T. (Okayama Coll. of Science, Japan). J. Nucl. Energy; 26: No. 8, 389-402(Aug 1972).

A generalized synthetic kernel for the elastic scattering is proposed for more rapid and precise computation of the neutron-slowing-down problem. In this generalized synthetic kernel, named the "G_n-kernel", higher slowing-down moments are taken into account than in the ordinary Greuling—Goertzel approximation. Two applications of the present synthetic kernel approximation are shown. One is the calculation of the Placzek function: the approximate Placzek function calculated from the G_n-kernel is shown to be composed of a nonoscillatory term and finite sums of exponential functions of lethargy. The other is the calculation of the fast neutron spectrum in vicinity of the strong scattering resonance. These numerical results reveal that the generalized synthetic kernel proposed is very useful for slowing-down calculations. (auth)

Nuclear Properties and Reactions, $A \leq 5$

Refer also to abstracts 58833, 59792, 59845, 59902, 59903, and 60116.

60095 OFF-ENERGY-SHELL EFFECTS IN DEUTERON-INDUCED DEUTERON BREAKUP. Duck, I. M.; Valkovic, V.; Phillips, G. C. (Rice Univ., Houston, Tex.). Phys. Rev. Lett.; 29: No. 13, 875-7(25 Sep 1972).

An improved phenomenological fit to the experimental data on the reaction $d + d \to d + n + p$ was achieved based on one-nucleon-exchange quasi-free nucleon—deuteron scattering by including a large off-energy-shell correction in the nucleon—deuteron scattering amplitudes. (auth)

60096 NEW METHOD FOR DETERMINING POLARIZATION STANDARDS IN NUCLEAR REACTIONS. Keaton, P. W. Jr.; Armstrong, D. D.; Hardekopf, R. A.; Kurjan, P. M.; Lee, Y. K. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 29: No. 13, 880-3(25 Sep 1972).

The application of a general method for measuring the difference of polarization observables from their maximum allowed value is discussed. Relatively crude double-scattering experiments determine the proton polarization for 12-MeV p-^{4}He scattering with an absolute uncertainty of 1 part in 1000. It is anticipated that these concepts can be applied to higher-energy reactions, where experiments do not lend themselves easily to precision measurements and where basic symmetries appear more likely to break down. (auth)

60097 ANALYSING POWERS iT_{11}, T_{20}, T_{21}, AND T_{22} IN DEUTERON–DEUTERON ELASTIC SCATTERING BETWEEN 6 AND 11.5 MeV. Grueebler, W.; Koenig, V.; Risler, R.; (and others) (Eidgenoessische Technische Hochschule, Zurich). Nucl. Phys.; A193: No. 1, 149-54(1972).

The angular distributions of the analyzing powers $iT_{11}(\theta)$, $T_{20}(\theta)$, $T_{21}(\theta)$ and $T_{22}(\theta)$ of the elastic scattering of polarized deuterons on deuterons have been measured at deuteron energies of 6.0, 8.0, 10.0 and 11.5 MeV. The vector component has small but non-zero values which change sign between 6.0 and 10.0 MeV. The tensor components have increasing values with increasing energy. The results are discussed in respect of resonances in ^{4}He and a term scheme is proposed for a complete phase-shift analysis. (auth)

60098 INVESTIGATION OF EXCITED STATES OF ^{4}He VIA THE ^{2}H(d,p)^{3}H AND ^{2}H(d,n)^{3}He REACTIONS USING A POLARIZED DEUTERON BEAM. Grueebler, W.; Koenig, V.; Schmelzbach, P. A.; (and others) (Eidgenoessische Technische Hochschule, Zurich). Nucl. Phys.; A193: No. 1, 129-48(1972).

The differential cross section $\sigma_0(\theta)$ and the analyzing powers $iT_{11}(\theta)$, $T_{20}(\theta)$, $T_{21}(\theta)$ and $T_{22}(\theta)$ of the reactions ^{2}H(d,p)^{3}H and ^{2}H(d,n)^{3}He have been measured. The ^{2}H(d,p)^{3}H reaction was measured at 9 energies between 3.0 and 11.5 MeV at lab angles between 7.5 and 160°. The reaction ^{2}H(d,n)^{3}He was measured at 10.0 and 11.5 MeV at cm angles ranging from 95° to 156°. The results were fitted with Legendre polynomials and the resulting coefficients analyzed for possible resonances in ^{4}He. Differences in the analyzing powers between the ^{2}H(d,p)^{3}H and the ^{2}H(d,n)^{3}He reactions can be explained by Coulomb effects. (auth)

60099 EXACT UNITARY MODEL CALCULATIONS OF n–d ELASTIC SCATTERING. Tandy, P. C. (Univ. of Surrey, Eng.); Cahill, R. T.; McCarthy, I. E. Phys. Lett.; 41B: No. 3, 241-3 (2 Oct 1972).

Results of calculations based upon a recently proposed exact unitary model for three-particle scattering are presented. The unitarization of the lowest-order elastic, break-up, and $3 \leftarrow 3$ graphs provides a good approximation to exact solutions of the Faddeev equations for 14-MeV n–d elastic scattering. (auth)

60100 SOME REMARKS ON ENERGY BOUNDS AND ON THE CONVERGENCE OF PERTURBATION EXPANSIONS. Mavromatis, H. A.; Singh, B. (American Univ. of Beirut, Lebanon). Phys. Lett.; 41B: No. 3, 251-6(2 Oct 1972).

Perturbation results to fifth order are compared to exact diagonalization for ^{4}He, ^{5}He, and ^{16}O. Except for ^{4}He, where both the complete $2\hbar\omega$ and the complete space to $4\hbar\omega$ is used, the analysis is restricted to the respective $2\hbar\omega$ spaces. Various upper bounds are also calculated and compared for these nuclei and also for ^{17}O. The results show very good convergence by fifth order, and also suggest that one can without much loss of accuracy stop at third order. An upper bound using results to third order is shown to be much better than the standard expression to this order and about as good as the standard expression to fifth order. An alternate and more accurate bound using the results to fifth order is also given. The above conclusions appear to be equally valid when only $2\hbar\omega$ excitations are included and when both $2\hbar\omega$ and $4\hbar\omega$ excitations are included. (auth)

60101 NON-COPLANAR NEUTRON–PROTON BREMSSTRAHLUNG. Celenza, L. S.; Gibson, B. F.; Liou, M. K.; Sobel, M. I. (Brooklyn Coll., New York). Phys. Lett.; 41B: No. 3, 283-6 (2 Oct 1972).

Theoretical npγ calculations at 200 MeV and 130 MeV are reported, including cases of noncoplanar kinematics. The internal amplitude is calculated to order K^0 by using the low-energy theorem. Results are in fair agreement with the data at 200 MeV. (auth)

60102 ^{2}H + d REACTIONS FROM 1.96 TO 6.20 MeV. Schulte, R. L.; Cosack, M.; Obst, A. W.; Weil, J. L. (Univ. of Kentucky, Lexington). Nucl. Phys.; A192: No. 3, 609-24(1972).

The differential cross sections of ^{2}H(d,d)^{2}H, ^{2}H(d,^{3}He)n, ^{2}H(d,p)^{3}H and ^{2}H(d,t)p have been measured in a gas scattering chamber at ten bombarding energies between 2.0 and 6.2 MeV with accuracies ranging from ±1.7% to ±3.4%. The differential cross section of ^{2}H(d,n)^{3}He has been measured at forward angles to an accuracy of ±2.5% at the same energies using a time-of-flight detection system. The neutron detection efficiency was calibrated from the ^{2}H(d,^{3}He)n cross sections, so the neutron production cross sections reported here do not depend on any previous neutron measurements. The ^{2}H(d,^{3}He)n cross sections have been converted into ^{2}H(d,n)^{3}He cross sections and Legendre polynomial fits are given for the complete angular distributions of ^{2}H(d,n)^{3}He. (auth)

60103 BREMSSTRAHLUNG IN α–α SCATTERING. Peyer, U.; Hall, J.; Mueller, R.; Suter, M.; Woelfli, W. (ETH, Zurich). Phys. Lett.; 41B: No. 2, 151-2(18 Sep 1972).

The bremsstrahlung cross section in $\alpha-\alpha$ scattering was determined for incident laboratory energies between 12.5 and 19.0 MeV. The experimental cross sections are compared with the theoretical calculations for external emission only. (auth)

60104 CHARACTERISTICS OF THE FIRST EXCITED STATE OF ^{5}He POPULATED BY THE ^{7}Li(d,α)^{5}He* REACTION. Gil, P.; Marquez, L.; Quebert, J. L.; Sztark, H. (Univ. Bordeaux, Gradignan, France). J. Phys. (Paris); 33: No. 4, 315-20(Apr 1972). (In French).

The reaction d + ^{7}Li → α + α + n was studied at 1 MeV, using α-α coincidence techniques, in order to study the characteristics of the first excited state of ^{5}He. The interference effects were taken into account and the following values were obtained: $E^* = 2.6$ MeV and $\Gamma = 7$ MeV. (France)

60105 ^{4}He(γ,pπ^-) CROSS SECTION AROUND Δ(1236). Argan, P. E.; Audit, G.; De Botton, N.; (and others) (CEN de Saclay, Gif-sur-Yvette, France). Phys. Rev. Lett.; 29: No. 17, 1191-94 (23 Oct 1972).

The cross section of the reaction $^4\text{He} + \gamma \rightarrow p + \pi^- +$ (ppn) was measured in the region of the first resonance for various values of the recoil momentum. An anomaly is observed for high values of this momentum, and a tentative explanation is suggested. (auth)

60106 CALCULATION OF THE COUPLING CONSTANT FOR DEUTERON EXCHANGE IN p–^{3}He SCATTERING. Kim, Y. E.; Tubis, A. (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett.; 29: No. 15, 1017-19(9 Oct 1972).

A simple extrapolation technique is used to determine the normalization C of the proton–deuteron tail of the ^{3}He wave function. With a wave function calculated using the Faddeev equations and the Reid soft-core potential $|C|^2 \approx 2.8$, in fair agreement with the value $|C|^2 \approx 2.2 \pm 0.3$ estimated by Bolsterli and Hale in a modified phase-shift analysis of p–^{3}He elastic scattering data. (auth)

60107 DESTRUCTIVE INTERFERENCE EFFECTS IN D-(p,2p)n AT E_p = 39.5 MeV. Rogers, J. G; Saylor, D. P.; Bronson, J. D.; Jain, Mahavir (Texas A and M Univ., College Station). Phys. Rev Lett.; 29: No. 17, 1181-4(23 Oct 1972).

The D(p,2p)n cross section was measured at E_p = 39.5 MeV by using a unique multidetector scattering chamber. The integrated cross section $d^4\sigma/d\Omega_4 dE_3 dE_4$ shows a prominent minimum due to destructive interference between the single-scattering term of the rescattering series and the higher-order terms of the series. This destructive interference accounts for the failure of the simple impulse approximation to predict correctly the magnitude and shape of the quasi-free scattering peak. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 59898, 60100, 60135, and 60166.

60108 (CONF-720901–2) SECONDARY GAMMA-RAY-PRODUCTION CROSS SECTIONS OF SEVERAL MATERIALS. Morgan, G. L.; Dickens, J. K.; Love, T. A.; Perey, F. G. (Oak Ridge National Lab., Tenn.). 1972. 11p. Dep. NTIS.

Absolute gamma-ray-production cross sections have been measured as a function of both incident neutron and emitted gamma-ray energy for tantalum, iron, silicon, and carbon. The data include gamma-ray energies between 0.7 and 10.6 MeV for incident neutron energies up to 20 MeV. Measurements were made at angles of 90° and 125° for tantalum and carbon and at 125° for iron and silicon. (auth)

60109 (LA–4780) PRELIMINARY EVALUATION OF THE NEUTRON AND PHOTON-PRODUCTION CROSS SECTIONS OF OXYGEN. Foster, D. G. Jr.; Young, P. G. (Los Alamos Scientific Lab., N. Mex.). Aug 1972. Contract W-7405-eng-36. 32p. Dep. NTIS.

A preliminary evaluation of the neutron-induced cross sections of ^{16}O has been completed for the energy region 10^{-5} eV to 20 MeV. Energy and angular distributions of secondary neutrons and photons are included. The recommended data are based mainly on experiment, although model calculations were used to augment the measurements in certain areas. In addition, results from an earlier evaluation performed at the Knolls Atomic Power Laboratory are also included to a limited extent. The evaluated data are available on magnetic tape in ENDF/B(III) format. (auth)

60110 (ORNL-TM-3974) SDT7: EXPERIMENT ON SECONDARY GAMMA-RAY PRODUCTION CROSS SECTIONS AVERAGED OVER A FAST-NEUTRON SPECTRUM FOR IRON, STAINLESS STEEL, OXYGEN, AND SODIUM. Maerker, R. E. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 16p. (ENDF-177). Dep. NTIS.

The experimental and calculational details for a CSEWG integral data testing shielding experiment are presented. This particular experiment measured the secondary gamma-ray production cross sections averaged over a fast-neutron spectrum for iron, a type 321 stainless steel, oxygen, and sodium. Production cross sections were binned into ~0.5-MeV wide gamma-ray energy intervals. (auth)

60111 LIMITS ON THE MAGNETIC MOMENTS OF DOUBLY ODD 4N + 2 NUCLEI WITH $T = 0$, $J^{\pi} = 1^+$. Pham Tri Nang (Centre de Physique Theorique de l'Ecole Polytechnique, Paris). Phys. Rev. Lett.; 29: No. 16, 1111-4(16 Oct 1972).

By assuming that the low-lying states of doubly odd nuclei contain only the two lowest SU(4) supermultiplets, the following lower and upper limits on the magnetic moments of ^6Li, $^{10}B^*$, and ^{18}F were derived using only experimental data on superallowed Gamow–Teller transitions: $(0.800 \pm 0.016)\mu_N \leq \mu(^6Li) \leq 0.88\ \mu_N$, $0.65\ \mu_N \leq \mu(^{10}B^*) \leq 0.88\ \mu_N$, $0.66\ \mu_N \leq \mu(^{18}F) \leq 0.88\ \mu_N$. The results show that relativistic corrections to the magnetic moment of ^6Li cannot exceed 7.3%. (auth)

60112 FAILURE OF THE COEXISTENCE MODEL TO ACCOUNT FOR OBSERVED TWO-NEUTRON PICKUP CROSS SECTIONS. Adelberger, E. G.; Debevec, P. T.; Garvey, G. T.; Ohanian, R. (Princeton Univ., N. J.). Phys. Rev. Lett.; 29: No. 13, 883-6(25 Sep 1972).

The (p,t) reaction on ^{18}O and ^{42}Ca was studied at $E_p = 41.7$ MeV. The observed yields to the 0^+, $T = 0$ states in ^{16}O and ^{40}Ca are at variance with distorted-wave Born-approximation predictions using the coexistence model to describe the initial and final states of the targets. By use of wave functions which employ a more extensive set of configurations, satisfactory agreement with the observed yields was achieved for the reaction $^{18}O(p,t)^{16}O$. (auth)

60113 ELASTIC SCATTERING OF POLARIZED DEUTERONS BY ^{12}C AT 30 MeV. Perrin, G.; Nguyen van Sen; Fiore, A.; (and others) (Institut des Sciences Nucleaires, Grenoble, France). Nucl. Phys.; A193: No. 1, 215-24(1972). (In French).

Angular distributions of the vector polarization of deuterons elastically scattered by ^{12}C have been measured at 20.5, 25.2 and 29.5 MeV. Asymmetries were measured with semiconductor telescopes. The beam polarization was determined simultaneously with a carbon polarimeter whose analyzing power was calibrated by means of the d-^4He scattering. Differential cross sections at 20.5 and 29.5 MeV are also presented. The results are analyzed in terms of the optical model. Two energy dependent average potentials are deduced. (auth)

60114 SEMI-LEPTONIC WEAK AND ELECTROMAGNETIC INTERACTIONS IN NUCLEI WITH APPLICATION TO ^{16}O. Donnelly, T. W.; Walecka, J. D. (Stanford Univ., Calif.). Phys. Lett.; 41B: No. 3, 275-80(2 Oct 1972).

Electron scattering is shown to provide a basis for analyzing semileptonic weak interactions in nuclei essentially independent of detailed models of nuclear wave functions. Application is made to ^{16}O. One result is the identification of a second-class-current detector. (auth)

60115 SPINS OF STATES IN ^{19}O NEAR 2.7 MeV EXCITATION. Crozier, D. J. (Univ. of Pennsylvania, Philadelphia); Fortune, H. T.; Middleton, R.; Wiza, J. L.; Wildenthal, B. H. Phys. Lett.; 41B: No. 3, 291-4(2 Oct 1972).

A distorted-wave analysis of angular distributions from the $^{17}O(t,p)^{19}O$ reaction leads to spin–parity assignments of $9/2^+$, $7/2^+$, and $3/2^+$ for the states at $E_X = 2.37$, 2.78, and 3.07 MeV, respectively, in agreement with recent γ-ray decay data, but not with assignments commonly quoted in the literature. (auth)

60116 NARROW RESONANCES AT THRESHOLDS IN LIGHT NUCLEI. Hackenbroich, H. H. (Univ., Cologne); Seligman, T. H. Phys. Lett.; 41B: No. 2, 102-4(18 Sep 1972).

Scattering states of light nuclei are discussed qualitatively in the supermultiplet scheme. It is shown that, in channels with loosely bound fragments having minimal isospin, maximal channel spin, and zero relative angular momentum, narrow "potential" resonances may occur close to threshold. (auth)

60117 ^{12}C–^{16}O ELASTIC SCATTERING. Baur, G.; Sharaf, M. A. (Max-Planck Institut fuer Kernphysik, Heidelberg). Phys. Lett.; 41B: No. 2, 113-14(18 Sep 1972).

Elastic scattering data of $^{16}O-^{12}C$ are analyzed by the Feynman graphs techniques. Comparisons with the experimental results are satisfactory. (auth)

60118 ELASTIC SCATTERING OF NEGATIVE PIONS FROM ^{16}O IN THE REGION OF THE (3,3) RESONANCE. Bercaw, R. W. (Lewis Research Center, Cleveland, Ohio); Vincent, J. S.; Boschitz, E. T.; (and others). Phys. Rev. Lett.; 29: No. 15, 1031-4(9 Oct 1972).

The elastic differential cross sections for $\pi^- - ^{16}O$ scattering were measured for pions with kinetic energies 160, 170, 220, 230, 240 MeV at laboratory angles from 15° to 77°. The cross sections are compared with the results of an optical-model calculation. (auth)

60119 RECOIL NUCLEAR POLARIZATION IN MUON CAPTURE. Devanathan, V.; Parthasarathy, R.; Subramanian, P. R. (Univ. of Madras). Ann. Phys. (N. Y.); 73: No. 1, 291-302(Sep 1972).

The polarization of recoil nuclei resulting from the absorption of polarized muons is investigated. The reaction $\mu^- + ^{12}C(J^P = 0^+) \rightarrow \nu_\mu + ^{12}B\ (J^P = 1^+)$ is chosen for the study since in this case the transition probability to the low-lying excited bound states of ^{12}B is found to be negligible when compared to the transition probability to the ground state of $^{12}B\ (J^P = 1^+)$. Numerical calculations are done using both the single particle j–j coupling shell model and the general 1p-shell wave functions, and it is found that the polarization of ^{12}B is insensitive to the nuclear model although the capture rate depends on it significantly. (2 tables) (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 38$

Refer also to abstracts 60108, 60110, 60153, and 60754.

60120 (AD-739346) HIGH-ENERGY ELASTIC ELECTRON SCATTERING FROM ^{24}Mg, ^{28}Si, AND S. Li, Gloria C.; Sick, Ingo; Yearian, Mason R. (Stanford Univ., Calif. High-Energy Physics Lab.). Jul 1971. Contract Nonr-225(67). 14p. (HEPL-647). NTIS.

High-momentum transfer elastic electron scattering data ($0.76 \leq q \leq 3.74$/fm) from ^{24}Mg, ^{28}Si, and S are presented and analyzed using phenomenological charge distributions; the oscillation in rho (r) due to the shell model structure is obtained. An analysis in terms of a Woods–Saxon nuclear potential is described and the 2s/1d occupation numbers are deduced. (auth) (NTIS)

60121 (COO-2176-1) PROGRESS REPORT, JANUARY 1, 1971–JUNE 30, 1972. (Columbia Univ., New York (USA). Div. of Nuclear Science and Engineering). 1972. Contract AT(30-1)-73. 66p. Dep. NTIS.

COPPER—neutron total cross section at 2.5 to 60 keV, (E)
SODIUM-23—neutron total cross section at 20 to 360 keV, (E)
THORIUM-232—neutron reactions at 21 eV to 4 keV, resonance parameters for, (E)
URANIUM-233—neutron fission of, resonance integrals for, (E)
URANIUM-235—neutron fission of, resonance integrals for, (E)
URANIUM-238—neutron reactions at 6 to 2352 eV, resonance parameters for, (E) (J.W.R.)

60122 STUDY OF THE REACTIONS $^{32}S(n,\alpha_0)^{29}Si$ AND $^{40}Ca(n,\alpha_0)^{37}Ar$ AT $E_n = 13.9$ MeV WITH A PARALLEL PLATE AVALANCHE COUNTER TELESCOPE. Brede, Hein Juergen (Univ., Tuebingen, Ger.). Z. Phys.; 254: No. 4, 375-84(1972). (In German).

The reactions $^{32}S(n,\alpha)^{29}Si$ and $^{40}Ca(n,\alpha)^{37}Ar$ were studied with 13.9-MeV neutrons by using two different counter telescopes. Absolute differential cross sections were measured for the transitions to the ground states of ^{29}Si and ^{37}Ar and to the (1.27 + 2.03 + 2.42)-MeV levels of ^{29}Si. The angular distribution of the ground states interpreted in terms of a simple pickup-reaction model was compared with a DWBA calculation using the code DWUCK. (5 figures, 1 table) (auth)

60123 ENERGY LEVELS OF ^{21}Na. Haas, F. X. (Mound Lab., Miamisburg, Ohio); Johnson, C. H.; Bair, J. K. Nucl. Phys.; A193: No. 1, 65-80(1972).

The energy levels of ^{21}Na are investigated with the ^{20}Ne(p,γ)^{21}Na and ^{20}Ne(d,n)^{21}Na reactions. From the γ-ray energy measurements the excitation energies in ^{21}Na are found to be 331 ± 3, 1717 ± 3, 2426 ± 2, 2800 ± 4, 3545 ± 3, 3679 ± 4, 3867 ± 4, 4117 ± 11 and 4297 ± 4 keV. A ^{20}Ne(p,γ)^{21}Na Q-value of 2434 ± 2 keV is deduced. Branching ratios are determined for the upper five levels. Direct non-resonant capture is observed to the 0.33 and 2.43 MeV states. Angular distributions for the ^{20}Ne(d,n)^{21}Na reaction are presented for all of these levels and for levels at 4453 ± 12 keV and 5009 ± 12 keV for incident deuteron energies of 3.60, 4.88, 5.57 and 5.94 MeV. The unbound 4.12 MeV state has a stripping pattern consistent with l = 1. Its lab width from the γ-ray work is 125 keV. The combined evidence of the branching ratios, reduced widths and stripping patterns show that the 4.12 eV level is the mirror of the 4.73 MeV level in ^{21}Ne. (auth)

60124 GAMMA DECAY OF LOW-LYING STATES IN ^{30}S AND ^{34}Ar. Caraca, J. M. G.; Gill, R. D.; Cox, A. J.; Rose, H. J. (Oxford Univ.). Nucl. Phys.; A193: No. 1, 1-13(1972).

Decay modes and lifetimes of low-lying levels in ^{30}S and ^{34}Ar were investigated by the Doppler-shift attenuation method using the ^{28}Si(^{3}He,n)^{30}S and ^{32}S(^{3}He,n)^{34}Ar reactions. The lifetimes measured in ^{30}S were (in fs): $\tau_m(2210) = 310 \pm 75$, $\tau_m(3402) = 160 \pm 45$ and $\tau_m(3664) > 1400$; and in ^{34}Ar: $\tau_m(2090) = 150 \pm 50$, $\tau_m(3286) = 120 \pm 65$ and $\tau_m(4513) = 300 \pm 80$, also in fs. These results are compared with theoretical calculations. A comparison of the E2 decay strengths in masses 30 and 34 is also made to test the isospin dependence of electromagnetic transitions. (auth)

60125 SOME COMMENTS ON THE CROSS SECTION OF ^{37}Cl FOR SOLAR NEUTRINO ABSORPTION. Lanford, W. A.; Wildenthal (Michigan State Univ., East Lansing). Phys. Rev. Lett.; 29: No. 9, 606-8(28 Aug 1972).

Nuclear wave functions from recent shell-model calculations are used to evaluate the log(ft) values relevant to the neutrino absorption cross section of ^{37}Cl. (auth)

60126 REORIENTATION MEASUREMENTS USING THE DOPPLER-SHIFT METHOD: STATIC QUADRUPOLE MOMENTS OF ^{20}Ne, ^{22}Ne, ^{24}Mg, ^{26}Mg, AND ^{28}Si. Schwalm, D. (Univ., Heidelberg); Bamberger, A.; Bizzeti, P. G.; (and others). Nucl. Phys.; A192: No. 3, 449-95(1972).

The static quadrupole moments of the first excited $I^\pi = 2^+$ states in ^{20}Ne, ^{22}Ne, ^{24}Mg, ^{26}Mg and ^{28}Si were measured via the reorientation effect observed in Coulomb excitation with beams of ^{32}S, ^{34}S and ^{37}Cl ions. The quadrupole moments were deduced from the Doppler-broadened γ-ray lineshapes observed at 0° with respect to the beam by means of a Ge(Li) detector. The results are: $Q(^{20}\mathrm{Ne},2^+) = -0.23 \pm 0.08$ e · b, $Q(^{22}\mathrm{Ne},2^+) = -0.18 \pm 0.04$ e · b, $Q(^{24}\mathrm{Mg},2^+) = -0.24 \pm 0.06$ e · b, $Q(^{26}\mathrm{Mg}, 2^+) = -0.16 \pm 0.04$ e · b (-0.12 ± 0.04 e · b), and $Q(^{28}\mathrm{Si}, 2^+) = +0.17 \pm 0.05$ e · b. Two values are quoted for ^{26}Mg corresponding to the two possible signs of an interference term arising from virtual excitations through the second excited 2^+ state of ^{26}Mg. A detailed description of the experimental technique and analysis is given, including the procedure whereby the semi-classical analysis of experimental lineshapes is modified to accord with a full quantal treatment of Coulomb excitation. Perturbing effects due to virtual E1 excitations and deorientation effects are calculated and found to be small. (auth)

60127 NUCLEAR CHARGE DISTRIBUTIONS OF THE ISOTOPES ^{24}Mg, ^{25}Mg, AND ^{26}Mg FROM ELASTIC ELECTRON SCATTERING. Curran, C. S.; Drake, T. E.; Johnston, A.; (and others) (Univ. of Glasgow). J. Phys., A (London); 5: No. 4, L39-42(Apr 1972).

Parameters for the ground-state nuclear charge distributions of the isotopes ^{24}Mg, ^{25}Mg, and ^{26}Mg were determined from elastic electron scattering in the momentum transfer range 0.20 to 1.15 fm^{-1}. Calculations using a Nilsson model including configuration mixing up to 7 hw show good agreement with experiment. (auth)

60128 STUDY OF LEVELS IN ^{25}Mg VIA THE ^{22}Ne(α,nγ)^{25}Mg REACTION. Kean, D. C.; Ollerhead, R. W. (Univ. of Guelph, Ont.) Can. J. Phys.; 50: No. 13, 1539-53(1 Jul 1972).

Levels in the nucleus ^{25}Mg were studied by measurement of the angular distributions and polarization of gamma rays from the ^{22}Ne(α,nγ)^{25}Mg reaction. Information regarding spins, parities, mixing ratios, and branching ratios was obtained for the levels between 2.7 and 4.7 MeV excitation. Spin and parity assignments of $\frac{5}{2}^+$ and $\frac{7}{2}^-$ have been made to the levels at 3.90 and 3.97 MeV. Mixing ratios have been determined or restricted for most of the observed transitions. The decay branch of the 3.40 MeV level to the ground state is found to be considerably stronger than previously reported, bringing the decay properties of this level into good agreement with the predictions of the simple rotational model. The significance of the results within the framework of the rotational model is discussed. There is evidence for considerable band mixing in levels belonging to the second $K^\pi = \frac{1}{2}^+$ and the $K^\pi = \frac{1}{2}^-$ bands. (auth) (Canada)

60129 NEUTRON CAPTURE CROSS SECTIONS OF ^{22}Na AND ^{58}Co. Werner, R. D.; Santry, D. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Energy; 26: No. 8, 403-8 (Aug 1972).

Activities of ^{22}Na and ^{58}Co were ion implanted into separate high-purity Al foils and used to measure the neutron capture cross section by the depletion method using high-resolution gamma-ray spectrometry. In a well-thermalized reactor neutron flux, effective cross section values of $2.83 \pm 0.06 \times 10^4$ barns for 2.6-yr ^{22}Na and $1.88 \pm 0.12 \times 10^3$ barns for 71-day ^{58}Co were measured relative to a ^{59}Co cross section of 37.09 barns. (auth)

60130 NEUTRON TOTAL CROSS SECTION OF ^{31}P BETWEEN 0.75 MeV AND 9.00 MeV. Kellie, J. D.; Islam, M. N.; Syme, D. B. C. B.; Crawford, G. I. (Univ. of Glasgow). J. Phys., A (London); 5: No. 7, 1090-4(Jul 1972).

The total neutron cross section of ^{31}P was measured at 0.75 to 9.00 MeV. Good agreement is obtained with the calculated values using the generalized optical model potential of Wilmore and Hodgson, (Nucl. Phys. 55: 673-94 (1964)). (auth)

60131 STRUCTURE OF ^{28}Si, SOME ANSWERS, AND THEIR PROBLEMS. Soyeur, M.; Zuker, A. P. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 41B: No. 2, 135-42(18 Sep 1972).

The energy levels of ^{28}Si were calculated in a small space, in a large space, and in an exact diagonalization by using the same Hamiltonian. Spins and parities of the levels and B(E2)'s are given, along with the partition occupancies of the ground-state rotational band. The influence of the interaction is discussed, and the matrix elements used are compared with those of Kuo [Nucl. Phys. A103, 71(1967)]. It is concluded that the validity of the model should be judged by the stability of the eigenvectors rather than the agreement of energy levels, and that large shell-model calculations magnify the effects of the interaction and thus allow discovery of details to which smaller cases are insensitive. In this way ^{28}Si yields more information about the two-body force than ^{18}O or ^{20}Ne, as many Hamiltonians give excellent results in the latter case and only few, in the former. (3 figures, 1 table) (R.W.R.)

60132 STATIC ELECTRIC QUADRUPOLE INTERACTION OF THE β-EMITTER ^{20}F PRODUCED BY CAPTURE OF POLARIZED NEUTRONS IN MgF$_2$ SINGLE CRYSTALS. Ackermann, H.; Dubbers, D.; Grupp, M.; (and others) (Univ., Heidelberg). Phys. Lett.; 41B: No. 2, 143-4(18 Sep 1972).

Polarized ^{20}F nuclei ($T_{1/2} = 11.2$ s, I = 2) were produced in a tetragonal MgF$_2$ single crystal by capture of polarized neutrons. Nuclear magnetic resonance was observed via the asymmetric β decay in an intermediate magnetic field of 4350 Oe, and yielded the quadrupole constant $|e^2 qQ/h| = 5.77 \pm 0.02$ MHz and $|Q(^{20}\mathrm{F})| = 0.012 \pm 0.002$b. (auth)

60133 STUDY OF THE PRINCIPAL DECAY MODES AND LIFETIMES OF LEVELS IN ^{29}Si BELOW 7.2 MeV. Bailey, D. C.; Carr, P. E.; Durell, J. L.; (and others) (Univ. of Liverpool, Eng.). J. Phys., A (London); 5: No. 4, 596-604(Apr 1972).

The principal decay modes and lifetimes of levels populated in the reaction ^{26}Mg(α,n)^{29}Si were studied. Lifetimes were measured by the Doppler shift attenuation method at beam energies of 5.0, 6.75, 8.0, and 9.25 MeV. There is good agreement with previous results and two new lifetimes of 20 ± 8 fs for the 5813 keV level and 47 ± 14 fs for the 7016 keV level were measured. Thirteen new lifetime limits were also obtained. The lifetime limit of the 5653 keV level restricts its spin to $\frac{9}{2}^+$. This level, and that at 7139 keV, are proposed as the $\frac{9}{2}^+$ and $\frac{11}{2}^+$ members of the $K^\pi = \frac{3}{2}^+$ rotational band, and evidence is presented for the inclusion of the 678-keV level in the $K = \frac{7}{2}^-$ band. (auth)

60134 γ-NEUTRINO ANGULAR CORRELATIONS IN MUON CAPTURE. Miller, G. H.; Eckhause, M.; Kane, F. R.; Martin, P.; Welsh, R. E. (Coll. of William and Mary, Williamsburg, Va.). Phys. Rev. Lett.; 29: No. 17, 1194-8(23 Oct 1972).

Doppler-broadened γ-ray transitions were observed for the first time in the reaction $\mu^- + (Z,A) \rightarrow (Z-1, A) + \nu_\mu$, which are suitable for analysis in terms of angular correlations between the neutrino and a de-excitation nuclear γ ray. The observed transitions are interpreted in terms of $\gamma-\nu$ correlation coefficients which are functions of the weak-interaction coupling constants. (auth)

60135 MIRROR ASYMMETRY OF FERMI β DECAY. Hardy, J. C.; Schmeing, H.; Geiger, J. S.; Graham, R. L.; Towner, I. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev. Lett.; 29: No. 15, 1027-30(9 Oct 1972).

Half-lives and branching ratios for the Fermi β decays of ^{18}Ne, ^{22}Mg, ^{26}Si, and ^{34}Ar were studied in experiments which employed a gas-transport system. The ft values for the last two are compared with the mirror decays of ^{26m}Al and ^{34}Cl. A difference of (4.6 ± 1.7)% is observed for mass 34 and may be attributable to unexpectedly large charge-dependent mixing. Possible implications are discussed with respect to Cabibbo theory and the existence of an intermediate vector boson. (auth)

60136 COUPLED-CHANNEL BORN-APPROXIMATION CALCULATION FOR THE TRANSITION ^{22}Ne(p,t)^{20}Ne(2$^-$, 4.97 MeV). Olsen, David K. (Univ. of Texas, Austin); Udagawa, Takeshi; Tamura, Taro; Brown, Ronald E. Phys. Rev. Lett.; 29: No. 17, 1178-81(23 Oct 1972).

The differential cross section at a proton energy of 39.8 MeV for the transition ^{22}Ne(p,t)^{20}Ne(2$^-$, 4.97 MeV), which is forbidden by the usual selection rules for a single-step process, is compared with a coupled-channel Born-approximation calculation using rotational wave functions of the adiabatic form. The calculated results are in good agreement with the experimental data. (auth)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 60108, 60110, 60112, 60122, 60129, 60153, 60164, 60166, 60252, 60276, and 60279.

60137 STUDY OF THE LOW-LYING ISOBARIC ANALOG STATES IN ^{52}Cr FROM (p,γ) AND (p,n) REACTIONS IN ^{51}V. Ahmed, N. (Atomic Energy Centre, Dacca, Bangladesh); Rahman, M. A.; Rahman, M.; Sen Gupta, H. M. Nuovo Cim.; 11A: No. 2, 476-86(21 Sep 1972).

Isobaric analog states in ^{52}Cr corresponding to the ground and low-lying levels of ^{52}V were located using a proton beam of energy up to 3.12 MeV, and the results are compared with data available from previous measurements. Coulomb displacement energy is obtained from the observed analog resonances, and is 79 keV larger than that given by the least-squares relation of Anderson et al. Some of the analog resonances exhibit a fine structure; the gross structure has a slightly asymmetric shape and is reasonably well fitted by Robson's theory. (4 figures, 2 tables) (auth)

60138 TWO-NUCLEON STRIPPING REACTIONS INDUCED BY ^{16}O IN ^{54}Fe, AND ^{58}Ni AT 80 MeV. Pougheon, F.; Roussel, P.; Colombani, P.; Doubre, H.; Roynette, J. C. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A193: No. 1, 305-22(1972).

Both the (^{16}O,^{14}N) and (^{16}O,^{14}C) reactions have been investigated on ^{54}Fe and ^{58}Ni target nuclei at 80 MeV incident energy. Both reactions are selective. The kinematical conditions have been found to act in two ways: (i) the high-spin states are enhanced and (ii) the states involving nucleons in the f- or p-shells are favored. Three groups of T = 1 analog states have been located in ^{56}Ni and ^{60}Zn from a comparison of the two transfer reactions on the same target, and configuration assignments are attempted. (auth)

60139 INVESTIGATION OF THE LOW-LYING STATES OF ^{58}Cu BY THE ^{58}Ni(p,nγ)^{58}Cu REACTION. Start, D. F. H.; Carlson, L. E.; Hutcheon, D. A.; (and others) (Oxford Univ.). Nucl. Phys.; A193: No. 1, 33-42(1972).

The γ-ray decay modes of the excited states of ^{58}Cu below 1.7 MeV have been investigated by neutron-γ and γ-γ coincidence techniques following the ^{58}Ni(p,nγ)^{58}Cu reaction. Accurate excitation energies have been obtained for the ^{58}Cu levels and the level at 1.65 MeV was found to be a doublet with energies 1.647 and 1.652 MeV. The Doppler-shift attenuation method has been used to measure the mean lifetimes of the following states: 1.052 MeV, $113 \pm ^{28}_{19}$ fsec; 1.428 MeV, >960 fsec; 1.550 MeV, >500 fsec; 1.647 MeV, >1300 fsec; 1.652 MeV, 50 ± 10 fsec. The lifetime and decay mode of the 1.052 MeV level establishes its spin as J = 1 while the spin of the 0.445 MeV state has been restricted to J = 2 or 3 by a singles γ-ray angular distribution measurement. The results are compared to shell-model predictions calculated using Kuo–Brown two-body matrix elements. (auth)

60140 CONTRIBUTION OF SINGLE-NUCLEON TRANSFER REACTIONS TO ^{40}Ar(τ,t)^{40}K. Coker, W. R.; Udagawa, T.; Wolter, H. H. (Univ. of Texas, Austin). Phys. Lett.; 41B: No. 3, 237-40(2 Oct 1972).

An analysis of the ^{40}Ar(^{3}He,t)^{40}K reactions populating the 0$^+$ analog state at 4.38 MeV and the 0$^+$ antianalog state at 1.65 MeV with incident ^{3}He energies of 35 and 18 MeV is made, including contributions from a pickup–stripping reaction mechanism as well as a conventional direct reaction mechanism. Agreement in magnitude and shape between calculated and experimental cross sections is best when both mechanisms are allowed to contribute. (auth)

60141 CALCULATION OF THE OPTICAL-MODEL POTENTIAL FOR NEUTRON SCATTERING BY ^{58}Ni IN A PARTICLE–VIBRATION COUPLING PICTURE. O'Dwyer, T. F.; Kawai, M.; Brown, G. E. (State Univ. of New York, Stony Brook). Contract AT(11-1)-3001. Phys. Lett.; 41B: No. 3, 259-63(2 Oct 1972).

The imaginary part of the optical model potential is calculated within a picture of strong coupling of core vibrations with the incident particle. Dependence of the optical-model potential upon choice of the energy interval over which averaging is carried out is studied. (auth)

60142 VARIATIONS OF NUCLEAR SHAPE AND DEFORMATION IN p–f SHELL. Parikh, J. K. (Bhabha Atomic Research Centre, Bombay). Phys. Lett.; 41B: No. 3, 271-4(2 Oct 1972).

The quadrupole moments of the first excited states and the BE2 values of the even–even nuclei in the p–f shell are calculated using the projected Hartree–Fock–Bogolyubov wave functions. The results are compared with the experimental data and with the predictions of the collective model. (auth)

60143 DOMINANCE OF THE STRIPPING OVER THE KNOCKOUT MECHANISM IN THE ^{40}Ca(α,p)^{43}Sc REACTION AT 28.5 MeV. Fischman, I. (Massachusetts Inst. of Tech., Cambridge); Thorn, C. E.; Bernstein, A. M.; Cline, D. Phys. Lett.; 41B: No. 3, 298-300(2 Oct 1972).

The ^{40}Ca(α,p)^{43}Sc reaction was studied at 28.5 MeV with an energy resolution of 15 keV. Below 3.5 MeV excitation energy eight previously assigned three-particle states were strongly excited; ten previously assigned four-particle–one-hole states were weakly excited (less than 4% of the ground state). These results indicate the strong dominance of the stripping over the knockout reaction mechanism. (auth)

60144 ACTIVATION CROSS SECTIONS FOR DEUTERON-INDUCED REACTIONS ON SOME ELEMENTS OF THE FIRST TRANSITION SERIES, UP TO 5.5 MeV. Coetzee, Paul P.; Peisach, Max (Southern Universities Nuclear Inst., Faure, South Africa). Radiochim. Acta; 17: No. 1, 1-6(May 1972).

Deuteron activation was carried out with deuteron beams up to 5.5 MeV with a Van de Graaff accelerator. Absolute cross sections were determined by gamma-ray spectroscopy using a Ge(Li)- and/or NaI(Tl)-detector. Excitation functions were obtained for the nuclear reactions: ^{50}Cr(d,p)^{51}Cr; ^{55}Mn(d,p)^{56}Mn; ^{58}Ni(d,n)^{59}Cu; ^{64}Zn(d,n)^{65}Ga; ^{50}Cr(d,α)^{48}V; ^{54}Fe(d,n)^{55}Co; and ^{60}Ni (d,n)^{61}Cu. (auth)

60145 DECAY OF ^{43}K. Waters, S. L. (Hammersmith Hospital, London). Radiochim. Acta; 17: No. 1, 63-4(May 1972).

Gamma energies and intensities from the decay of ^{43}K were measured using a Ge(Li) detector. An estimation for the ^{23}K half-life was made using a well-type NaI detector. The ^{43}K activity was produced by the ^{40}Ar (α,p) reaction. The results are compared with previous data. (J.W.R.)

60146 TRANSITION RATES BETWEEN $(1f_{7/2})^2$ STATES IN ^{42}Sc. Bertin, M. C.; Kumbartzki, G. J.; Hirko, R. G. (Stanford Univ., Calif.). Nucl. Phys.; A192: No. 3, 524-8(1972).

Mean lifetimes were measured for two members of the $(1f_{7/2})^2$ octet in ^{42}Sc with the recoil-distance method. For the 1491 keV (3$^+$) level τ = 45 ± 7 ps, and for the 1511 keV (5$^+$) level τ = 74 ± 11 ps were found. (auth)

60147 CALCIUM ISOTOPES AND N = 28 ISOTONES AND THE OPTICAL MODEL. Lombardi, J. C.; Boyd, R. N.; Arking, R.; Robbins, A. B. (Rutgers–The State Univ., New Brunswick, N. J.). Nucl. Phys.; A192: No. 3, 641-50(1972).

Differential cross-section and analyzing-power angular distributions have been measured for protons elastically scattered from ^{40,44,48}Ca, ^{50}Ti, ^{51}V, ^{52}Cr and ^{54}Fe. The rms radii of the real-central potentials were determined from the optical-model analyses of the angular distributions. From these results and the rms radii of the charge distributions, the rms radii of the neutron distributions were calculated and found in this analysis to be larger than the rms radii of the proton distributions in the isotones ^{48}Ca, ^{50}Ti, ^{51}V, ^{52}Cr and ^{54}Fe. This analysis yields an rms radius for the neutron distribution in ^{48}Ca which is larger than that determined from Coulomb energy-difference measurements. (auth)

60148 (d,α) REACTIONS WITH ^{46}Ti AND ^{48}Ti AT 26.7 MeV. Guichard, A.; Bedjidian, M.; Grossiord, J. Y.; (and others) (Univ., Lyon). Nucl. Phys., A192: No. 1, 125-38(1972). (In French).

The (d,α) reactions on ^{46}Ti and ^{48}Ti have been investigated with 26.7-MeV incident deuterons. Angular distributions of most excited levels have been obtained. Theoretical analysis has been performed on the basis of the two-nucleon transfer theory of Glendenning. (auth)

60149 LIFETIME MEASUREMENTS OF LOW-LYING LEVELS IN ^{47}Sc. Barci, V.; Brandolini, F.; Morando, M. (Univ., Padua). Nuovo Cim.; 11A: No. 1, 1-12(1 Sep 1972).

The mean lives of some low-lying levels in ^{47}Sc were measured using the Doppler-shift-attenuation method with $p-\gamma$ coincidences in the ^{44}Ca(α,pγ)^{47}Sc reaction. The following values were obtained: >8 ps, (4.5 ± 1.6) ps, (90 ± 35) fs, >6 ps, (1.4 ± 0.4) ps, (300 ± 80) fs, (440 ± 80) fs, <70 fs, (570 ± 120) fs, (120 ± 60) fs, and (450 ± 170) fs for the levels at 808, 1147, 1297, 1391, 1404, 1798, 1857, 1878, 2002, 2207, and 2410 keV, respectively. Branchings of levels were also assigned. The present measurement allows the proposal of a nearly complete level scheme for low-lying states in ^{47}Sc. M1 transitions are rather fast (of order of 0.1 W.u.), and E1 transitions are not very hindered (of order of few 10^{-4} W.u.). (auth)

60150 NUCLEAR HARTREE–FOCK CHARGE DISTRIBUTIONS AND ELECTRON SCATTERING. Faessler, A. (Kernforschungsanlage, Juelich, Ger.); Galonska, J. E.; Ehlers, J. W.; Moszkowski, S. A. Nuovo Cim.; 11A: No. 1, 63-76(1 Sep 1972).

The charge distributions of ^{40}Ca, ^{48}Ca, and ^{208}Pb calculated in the Hartree–Fock (HF) approach are tested by the elastic electron scattering data. The cross section calculated with charge distributions found employing density-dependent (MDI of Ehlers and Moszkowski, α force of Nemeth and Ripka) and density-independent forces (Yale–Shakin, Brink–Boeker B1) are compared. Both density-dependent forces show good agreement up to high momentum transfer. In comparison to these results the agreement of the density-independent forces is poor. (auth)

60151 CLUSTER EFFECTS IN ELASTIC α SCATTERING USING A NEW $\alpha-\alpha$ INTERACTION. Thompson, W. J. (Univ. of North Carolina, Chapel Hill). Particles Nucl.; 4: No. 1, 38-41(Jul 1972).

An attractive, L-independent optical potential recently shown to describe the energy dependence of all $\alpha-\alpha$ phase shifts is used to recalculate α-cluster effects in ^{40}Ca(α,α)^{40}Ca at 29 MeV. The α-cluster effects are even smaller than those previously obtained with repulsive-core, L-dependent $\alpha-\alpha$ potentials. The null results suggest that the α-particle optical-model potential for target nuclei above A = 40 is insensitive to any even–odd L-dependence due to α clustering. (1 figure) (auth)

60152 TRANSFORMATION PROPERTIES OF THE EFFECTIVE TRANSITION OPERATOR. Goode, Philip; West, Bruce J. (Univ. of Rochester, N. Y.). Particles Nucl.; 4: No. 1, 26-37 (Jul 1972).

A multipole decomposition of the matrix elements of the effective transition operator is made in both particle–particle (pp) and hole–hole (hh) nuclei. It is found that the many-body part of this operator may be represented by an effective two-body multipole coefficient. This coefficient transforms by a phase between the pp and hh nuclei which is different from the one-body part of the operator. This formalism is applied to the ^{42}Sc(pp) and ^{54}Co (hh) cases, where it is seen that the general structure of ^{42}Sc can be predicted from that of ^{54}Co. (2 figures, 1 table) (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 60121, 60138, 60142, 60144, 60166, 60171, and 60754.

60153 (BARC–608) VAN DE GRAAFF LABORATORY PROGRESS REPORT. David, T. P. (comp.) (Bhabha Atomic Research Centre, Bombay (India)). 1972. 73p. Dep. NTIS (U. S. Sales Only).

BROMINE-79—proton reactions (p,n), conversion electron and gamma spectra from, (E)
BROMINE-81—proton reactions (p,n), conversion electron and gamma spectra from, (E)
CHLORINE-33—energy levels from sulfur-32 (p,γ) reactions, resonance parameters for, (E)
CHROMIUM ISOTOPES—nuclear binding energies, neutron separation energies, and pair separation energies of, Hartree–Fock–Bogolyubov calculations of, (T)
—energy level transitions in, projected Hartree–Fock–Bogolyubov calculations for, (T)
—neutron occupation probabilities in, projected Hartree–Fock–Bogolyubov calculations of, (E)
COPPER-65—energy levels from proton elastic scattering on nickel-64, (E)
FLUORINE-19—alpha reactions (α,n) and (α,p) at 3.96 to 4.55 MeV, excitation functions for, (E)
GERMANIUM-70—neutron occupation probabilities in, projected Hartree–Fock–Bogolyubov calculations of, (E)
INSTRUMENTS—development at Bombay Van de Graaff Laboratory, 1971
IONS—implantation in solids, research at Bombay on, 1971
IRON ISOTOPES—energy level transitions in, projected Hartree–Fock–Bogolyubov calculations for, (T)
—neutron occupation probabilities in, projected Hartree–Fock–Bogolyubov calculations of, (E)
—nuclear binding energies, neutron separation energies, and pair separation energies of, Hartree–Fock–Bogolyubov calculations of, (T)
NEUTRON SPECTROMETERS—description of time-of-flight fast, for neutron–gamma coincidence experiments
NICKEL ISOTOPES—neutron occupation probabilities in, projected Hartree–Fock–Bogolyubov calculations of, (E)
NICKEL-64—proton elastic scattering at 3.150 to 4.025 MeV, excitation function for, (E)
PALLADIUM-108—energy level at 434 keV, g factor and lifetime for, (E)
PALLADIUM-110—energy level at 374 keV, g factor and lifetime for, (E)
RUTHENIUM-104—energy level at 360 keV, g factor and lifetime for, (E)
SELENIUM-75—energy levels of, lifetimes, multipolarities, and spins of, (E)
TITANIUM ISOTOPES—nuclear binding energies, neutron separation energies, and pair separation energies of, Hartree–Fock–Bogolyubov calculations of, (T)
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—neutron occupation probabilities in, projected Hartree–Fock–Bogolyubov calculations of, (E)
VAN DE GRAAFF ACCELERATORS—development and operation of Bombay 5.5-MeV, 1971
—experimental facility at Bombay 5.5-MeV, ion implantation
ZINC ISOTOPES—neutron occupation probabilities in, projected Hartree–Fock–Bogolyubov calculations of, (E)
ZINC-66—proton elastic scattering on, excitation functions for, (E)
ZINC-67—energy levels from proton elastic scattering on zinc-66, resonance parameters for, (E) (W.H.K.)

60154 DETERMINATIONS OF NUCLEAR LEVEL HALFLIVES IN ^{85}Rb AND ^{237}Np AND THEIR USE AS TIMING STANDARDS. Miller, G. H.; Dillard, P.; Eckhause, M.; Welsh, R. E. (Coll. of William and Mary, Williamsburg, Va.). Nucl. Instrum. Methods; 104: No. 1, 11-12(1972).

The application of nuclear lifetimes in the nanosecond range to the calibration of nuclear timing systems is discussed. More precise measurements of the lifetimes of the 517-keV level in ^{85}Rb and the 60-keV level in ^{237}Np are presented. (1 table) (auth)

60155 CORE-EXCITATION CALCULATIONS IN ^{75}As. Saayman, R.; Celliers, P. J. (Univ. of Stellenbosch, S. Afr.). Z. Phys.; 254: No. 4, 286-92(1972).

The nuclear properties of the low-lying negative parity states in ^{75}As are discussed in terms of the excited-core model. The core and particle parameters were determined by a simultaneous fitting of the available data by a least-square iteration program. (4 tables) (auth)

60156 LOW-LYING STATES OF ^{80} ^{82}Br FROM (d,p) REACTIONS. Cheung, H. C. (McGill Univ., Montreal); Lee, J. K. P.; Kitching, J. E.; Mark, S. K.; Li, Tseh Y. Nucl. Phys.; A193: No. 1, 225-35(1972).

The reactions ^{79,81}Br(d,p)^{80,82}Br have been studied at a bombarding energy of 12 MeV. Thirty-two levels below 2.0 MeV excitation energy have been identified in ^{80}Br and twenty-one levels below 2.2 MeV excitation energy have been identified in ^{82}Br. Transferred orbital angular momenta and spectroscopic information have been deduced from a DWBA analysis of the proton differential cross sections. It has been found that the lowest-lying excited states may arise from the coupling of a $2p_{3/2}$ proton with the stripped neutron captured in either one of the $1g_{9/2}$ or $2p_{1/2}$ orbits. (auth)

60157 ELASTIC AND INELASTIC PROTON SCATTERING FROM ^{86}Sr. Ramayya, A. V.; Ford, J. L. C. Jr.; Robinson, R. L.; Hamilton, J. H. (Vanderbilt Univ., Nashville). Nucl. Phys.; A193: No. 1, 186-92(1972).

Angular distributions of elastically and inelastically scattered 12 MeV protons from ^{86}Sr have been measured for angles between 24 and 165°. Inelastic scattering to 20 levels in ^{86}Sr were observed, and angular distributions measured for the ground state and excited states at 1076, 1854, 2482 and 2997 keV. The 2482 keV level appears to be the octupole state, rather than the 2997 keV level which also has spin-parity 3^-. Quadrupole and octupole deformation parameters $\beta_2 = 0.130$ and $\beta_3 = 0.153$ were extracted from the experimental cross sections for inelastic scattering to the 2^+ and 3^- states at 1076 and 2482 keV, respectively, by means of DWBA theory and coupled-channel calculations. The coupled-channel calculation for the differential cross section for the possible two-phonon 2^+ state at 1854 keV indicates that this state has a limited phonon-like character. (auth)

60158 COULOMB EXCITATION OF ^{81}Br. Robinson, R. L.; McGowan, F. K.; Milner, W. T.; Stelson, P. H. (Oak Ridge National Lab., Tenn.). Nucl. Phys.; A193: No. 1, 14-32(1972).

Coulomb excitation of the low-lying levels in ^{81}Br was effected with 2.5 to 8.2 MeV α-particles and 33 MeV ^{16}O ions. Gamma-ray energies and yields, γ-ray angular distributions, in one instance a γ-γ angular correlation, and Doppler-broadened γ-ray peaks were obtained. Level energies, spins, B(E2) and B(M1) transition probabilities and half-lives were deduced from these data for states at 275.9, 538.2, 566.0, 650.0, 767.1, 828.5, 836.5 and 1322.7 keV. The level properties are compared to those calculated by Stewart and Castel using an intermediate-coupling unified model. (auth)

60159 INTERFERENCE EFFECTS IN THE EMISSION OF GAMMA RAYS AFTER CAPTURE OF POLARIZED NEUTRONS BY POLARIZED ^{59}Co NUCLEI. Reddingius, E. R. (Reactor Centrum Nederland, Petten); Bosman, J. J.; Postma, H. Phys. Lett.; 41B: No. 3, 301-3(2 Oct 1972).

Emission of γ rays after capture of polarized thermal neutrons by polarized ^{59}Co nuclei was studied at 0.065 eV. In the analysis interference between competing capturing states was taken into account. Spins could be assigned to a number of states of ^{60}Co. (auth)

60160 CROSS-SECTIONS OF (n,p) REACTIONS INDUCED IN NICKEL ISOTOPES BY REACTOR FAST NEUTRONS. Hansen, J. R.; Steinnes, E. (Institutt for Atomenergi, Kjeller, Norway). Radiochim. Acta; 17: No. 1, 46-8(May 1972).

Cross sections of some (n,p) reactions induced in nickel by fast reactor neutrons have been determined. A fast radiochemical method based on anion exchange in strong hydrochloric acid and subsequent precipitation with α-nitroso-β-naphthol was used for the isolation of the cobalt reaction products. The following results were obtained: ^{60}Ni(n,p)^{60m}Co, 1.98 ± 0.20 mb; ^{60}Ni(n,p)^{60}Co (total), 4.4 ± 1.0 mb; ^{61}Ni(n,p)^{61}Co, 1.63 ± 0.12 mb; ^{62}Ni(n,p)^{62}Co, $(9 \pm 3) \cdot 10^{-3}$ mb. All cross sections are based upon the value 105 mb for the reaction ^{58}Ni(n,p)^{58}Co. (auth)

60161 EXPERIMENTAL DETERMINATION OF MEAN CROSS SECTIONS FOR A FISSION SPECTRUM. Francois, J. P. Ghent; Ghent Rijksuniversiteit (1971). 261p. (In Dutch).

Thesis.

A survey is given of the definitions of the mean cross sections of threshold reactions induced in a fission neutron spectrum and of related concepts. Closed formulas were derived for the integral of the fission neutron spectrum and for the mean energy of the fission neutrons. In addition, the effective energy for about twenty (n,2n) reactions was computed. The mean fission neutron cross section of the ^{103}Rh(n,p)^{103}Ru, ^{103}Rh(n,2n)^{102}Rh, ^{103}Rh(n,2n)^{102m}Rh, and ^{55}Mn(n,2n)^{54}Mn reactions was determined experimentally, and an upper limit given for the mean fission neutron cross section of the ^{103}Rh(n,3n)^{101}Rh reaction. The mean cross section of the ^{60}Ni(n,p)^{60}Co reaction was estimated. The effective cross section of the ^{65}Ni(n,γ)^{66}Ni reaction was also determined. (auth) (Netherlands)

60162 DECAY OF ^{78}As. Fettweis, P. (CEN/SCK, Mol, Belgium); Del Marmol, P.; Aras, N. K. Radiochim. Acta; 17: No. 1, 55-7(May 1972).

A radiochemical procedure for the separation of germanium from fission products was used to study the decay chain ^{78}Ge → ^{78}As → ^{28}Se. A Ge(Li) detector was used to measure energies and intensities of γ rays from ^{78}Ge and ^{78}As. The β branching to the ground state of ^{78}Se was determined. (J.W.R.)

60163 CORE EXCITATION OF THE $g_{9/2}$ ANALOG AND ANTI-ANALOG STATES IN ^{59}Cu. Maripuu, S.; Manthuruthil, J. C.; Poirier, C. P. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). Phys. Lett.; 41B: No. 2, 148-50(18 Sep 1972).

The $g_{9/2}$ isobaric analog state of ^{59}Cu was studied with the ^{58}Ni(p,p)^{58}Ni and ^{58}Ni(p,γ)^{59}Cu reactions. Shell-model calculations with different configuration spaces indicate a complex core structure in the $g_{9/2}$ isobaric analog and anti-analog states. (auth)

60164 j DEPENDENCE OF HEAVY-ION–INDUCED REACTIONS. Kovar, D. G.; Becchetti, F. D.; Harvey, B. G.; (and others) (Univ. of California, Berkeley). Phys. Rev. Lett.; 29: No. 15, 1023-7(9 Oct 1972).

The (^{16}O,^{15}N) and (^{12}C,^{11}B) reactions were studied on targets of ^{54}Fe, ^{62}Ni, and ^{208}Pb at incident ^{16}O and ^{12}C energies of 104 and 78 MeV, respectively. The two reactions are observed to populate states in the residual nuclei with different strengths, depending on the j values of the final states. These results are believed to be a consequence of the selection rules for these reactions, and suggest that spectroscopic assignments are possible with the use of heavy-ion reactions to complement other measurements. (auth)

Nuclear Properties and Reactions, $90 \leq A \leq 149$

Refer also to abstracts 59219, 59220, 59393, 59566, 60153, 60161, 60754, and 60755.

60165 (JINR–P7-6604) MEASUREMENT OF COINCIDENCES BETWEEN POSITRONS AND DELAYED PROTONS FOR ^{109}Te. Bogdanov, D. D.; Karnaukhov, V. A.; Petrov, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

A spectrum of delayed protons was measured with and without positron coincidence for the product Te from the reaction ^{96}Ru(^{16}O, 3n)^{109}Te. The ratio of two spectra was compared with the computed energy function which was determined by the relative probabilities of positron emission and electron capture during the transition of ^{109}Te into the proton-unstable state ^{109}Sb. $(Q_0 - B_p) = 7.14 \pm 0.10$ MeV, where Q_0 is the energy of K-capture of ^{108}Te, and B is the proton binding energy in ^{109}Sb. (tr-auth)

60166 (JUL–813-RX) GAMMA ENERGIES. PART III. Meixner, Chr. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Dec 1971. 327p. (In German). Dep. NTIS (U. S. Sales Only).

This volume is devoted to two tables. The first, fission products arranged according to energy, lists the nuclide, gamma energy, intensity, half-life, daughter, and fission yield. The other table, nuclei arranged according to half-life, lists the nuclide, half-life, decay constant, energy, and intensity. (R.W.R.)

60167 K-CONVERSION COEFFICIENT NEAR THRESHOLD OF THE 30 keV ISOMERIC TRANSITION IN ^{108m}Ag DECAY. Schmidt-Ott, W.-D.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Z. Phys.; 254: No. 4, 281-5(1972).

With calibrated Ge(Li) x-ray detectors K x rays in the conversion of the 30-keV isomeric transition in the decay of ^{108m}Ag were observed in coincidence with 79-keV γ rays. In this way the fraction of 30-keV transitions which take place by K conversion was measured to be $(2.44 \pm 0.23) \times 10^{-2}$. By using a theoretical total conversion coefficient (K conversion contributes only a minor part of the total conversion coefficient), an experimental value of the K-conversion coefficient was obtained, $\alpha_K = (1.07 \pm 0.10) \times 10^4$ (where the error represents twice the standard deviation to which the error in the detector efficiency has been added linearly). This value agrees with the theory of Hager and Seltzer for M4 conversion. The energy of the cascading γ ray was remeasured to be 79.20 ± 0.05 keV. (1 figure) (auth)

60168 GIANT MULTIPOLE RESONANCES IN ^{90}Zr OBSERVED BY INELASTIC ELECTRON SCATTERING. Fukuda, S.; Torizuka, Y. (Tohoku Univ., Sendai). Phys. Rev. Lett.; 29: No. 16, 1109-11(16 Oct 1972).

Inelastic electron scattering from the giant dipole resonance region in ^{90}Zr was measured. In addition to the usual dipole resonance new resonances were found at 14.0 MeV and around 28 MeV. The spins and parities and transition strengths of these states are discussed. (auth)

60169 NUCLEAR ISOMERS IN ^{113}Sn, ^{111}Sn, ^{117}Te, AND ^{115}Te. Brinckmann H. F. (Deutsche Akademie der Wissenschaften, Berlin); Fromm, W. D.; Heiser, C.; (and others). Nucl. Phys.; A193 No. 1, 236-46(1972).

Short-lived isomers have been observed in ^{113}Sn, ^{111}Sn and ^{115}Te by pulse activation of enriched Cd and Sn isotopes with α-particles and ^{3}He beams. The isomeric decay of ^{117}Te has been re-investigated. Decay schemes of the isomers were determined by γ-ray measurements, using Ge(Li) detectors and by conversion-electron spectroscopy, using Si(Li) drift detectors as well as a broad range electron spectrometer. The isomeric states and the states populated in the isomeric decay are single-particle states. In the odd Sn isotopes their sequence and variations with neutron number have been confirmed. The decay schemes in the odd Te nuclei, however, can be understood if the main tendencies of the single-particle sequences have shifted to isotopes with two neutrons more than in the comparable odd Sn isotopes. The half-life of the highly excited isomeric state in ^{114}Sn has been determined as 840 ± 70 ns. (auth)

60170 LOW-SPIN STATES IN ^{110}Cd AND ^{112}Cd. Kawase, Y.; Okano, K.; Uehara, S.; Hayashi, T. (Kyoto Univ.). Nucl. Phys.; A193: No. 1, 204-14(1972).

Gamma-transitions in the decays of 24.7 sec ^{110g}Ag and 13.3 min ^{112g}In have been studied with Ge(Li) detectors and a multi-counter goniometer to elucidate low-spin excited states in ^{110}Cd and ^{112}Cd. Five new levels at 1732, 2079, 2287, 2332 and 2662 keV in ^{110}Cd and three new levels at 2124, 2155 and 2300 keV in ^{112}Cd have been established from the decays of 1^+ states of parent nuclei. The 0^+ assignments to the levels at 1473, 2079 and 2662 keV in ^{110}Cd and at 1224 and 1870 keV in ^{112}Cd have been confirmed by angular-correlation measurements. Mixing ratios of the $2_3^+-2_1^+$ transitions have been determined. Log ft values of allowed β-decays from the 1^+ states are presented. Discussions on the low-spin states of the Cd isotopes are given in the light of the collective model. (auth)

60171 SPIN CUTOFF FACTORS FROM (n,2n) REACTIONS OF NUCLEI WITH N < 50. Horvath, D.; Kiss, A. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 31: No. 4, 327-33(1972).

The available experimental data on isomeric ratios measured in (n,2n) reactions are re-evaluated using a method based on the HUIZENGA–VANDENBOSCH assumptions. So far only the experimental values of isomeric (n,2n) cross section ratios reported for nuclei with N < 50 at 14 MeV have been re-analyzed. The dependence of the extracted spin cut-off factors on the parameters used is discussed, and the latter are compared with the values predicted by the Fermi gas model; their ratios are found to be about 0.5. (auth)

60172 HIGH-SPIN YRAST STATES IN ^{132}Ce. Taras, P.; Dehnhardt, W.; Mills, S. J.; (and others) (Univ., Heidelberg). Phys. Lett.; 41B: No. 3, 295-7(2 Oct 1972).

Yrast states up to spin 18 were identified in ^{132}Ce. The energies and spins of the levels suggest the existence of two fairly well-behaved collective bands. The results are compared with those obtained in the rare earth deformed region. (auth)

60173 $J^\pi = {}^{11}/_{2(1)}^{-}$ ISOMERIC STATE IN THE ODD-PROTON N = 82 NUCLEI. Waroquier, M.; Van Den Berhe, G. (Rijksuniversiteit, Ghent). Phys. Lett.; 41B: No. 3, 267-70(2 Oct 1972).

The ${}^{11}/_{2(1)}^{-} \rightarrow {}^{7}/_{2(1)}^{+}$ and ${}^{11}/_{2(1)}^{-} \rightarrow {}^{5}/_{2(1)}^{+}$ transitions are studied in the odd-proton N = 82 nuclei ^{137}Cs, ^{139}La, ^{141}Pr, ^{143}Pm, and ^{145}Eu. The experimental value of 10.3 ± 0.7 fm^2(nm)^2 for the B(M2; ${}^{11}/_{2(1)}^{-} \rightarrow {}^{7}/_{2(1)}^{+}$) in ^{143}Pm agrees very well with the theoretically obtained value of 11.41 fm^2(nm)^2 in a one- and three-quasi-particle description, if an effective gyromagnetic ratio, g_s^{eff}, of $\frac{1}{2}g_s^{sp}$ is used. (auth)

60174 g-FACTOR OF THE 91 keV STATE IN ^{147}Pm. Singh, Vikram (Punjab Univ., Chandigarh, India). Indian J. Pure Appl. Phys.; 10: No. 1, 23-5(Jan 1972).

The g-factor of the 91 keV $(\frac{5}{2})^+$ state has been measured using the integral reversed field method of perturbed angular correlation in an external magnetic field of 3.6 kG. The gamma ray cascade 319-91 keV through this level was used for this purpose. The attenuation coefficient G_2 due to time-dependent perturbations was also measured by studying the anisotropy as a function of time by delayed coincidence technique using lead-loaded plastic scintillator for detecting low energy 91 keV gamma rays. The results obtained in the present measurement are: $G_2(\infty) = 0.83 \pm 0.03$, $g = 1.57 \pm 0.29$. Using the known value of spin $(\frac{5}{2})^+$ of the 91 keV state, the magnetic moment (μ) is found to be 3.91 ± 0.62 nm. (auth)

60175 INELASTIC SCATTERING OF PROTONS FROM ^{100}Mo AND ^{98}Mo. Awaya, Yohko; Matsuda, Kazuhisa; Wada, Takeshi; (and others) (Inst. of Physical and Chemical Research, Saitama, Japan). J. Phys. Soc. Jap.; 33: No. 4, 881-9(Oct 1972).

Angular distributions of elastically and inelastically scattered protons from ^{100}Mo and ^{98}Mo were measured at $E_p = 14.7$ MeV. Results were analyzed in terms of the optical model and the distorted-wave Born approximation theory. In addition, the differential cross sections for the first 2^+ and 3^- states and those for the possible members of two-quadrupole-phonon triplet were compared with coupled-channel calculations. Reasonable agreements between the experiment and the theory were obtained except for the second 0^+ state of ^{100}Mo. Admixture of one-phonon component was required for the second 2^+ state. (auth)

60176 PRESENT STATUS OF DELAYED NEUTRON STUDY. Takekoshi, Eiko; Kuroi, Hideo; Igarasi, Sin-iti (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 14: No. 7, 340-56(Jul 1972). (In Japanese).

A note is presented on the present status of the delayed neutron study, in reference to (1) delayed neutron precursors in the field of nuclear physics, (2) delayed neutron parameters relating to the reactor kinetics, (3) an applied problem-nondestructive assay, and (4) items on delayed neutron study found in "Compilation of EANDC Request for Nuclear Data Measurements (RENDA)". (1), (2), (3) and (4) are discussed separately, but in their mutually related aspects. (auth)

60177 CORRELATION BETWEEN (n,γ) AND (d,p) REACTION ON ^{139}La. Fubini, A. (CNEN, Rome). Lett. Nuovo Cim.; 4: No. 10, 430-4(8 Jul 1972).

The γ-ray spectrum from thermal neutron capture by ^{139}La was studied using a pair spectrometer with a Ge(Li) detector and two NaI(Tl) crystals. The γ transitions in ^{140}La are compared with results from the ^{139}La(d,p)^{140}La reactions. Correlation coefficients were obtained for l = 1 and l = 3 levels. (J.W.R.)

60178 STRUCTURE OF STATES IN THE MASS-90 REGION BY (p,p′γ) ANGULAR CORRELATIONS AT THE $\frac{5}{2}^+$(g.s.) ANALOG RESONANCES. I. THE ^{94}Mo(p,p′γ) REACTION. Cue, N.; Plesser, I.; Vager, Z.; Wheeler, G. F. (State Univ. of New York, Stony Brook). Nucl. Phys.; A192: No. 3, 581-94(1972).

Angular correlations between the inelastically scattered protons to the 0.871 MeV (2^+), 1.582 MeV (4^+), 1.868 MeV (2^+) and 2.08 MeV states of ^{94}Mo and the subsequent $2^+ \rightarrow 0^+$ γ-rays were measured as a function of incident energy near the $\frac{5}{2}^+$ (g.s.) analog in ^{95}Tc. General arguments, which take into account compound nuclear enhancement, were used to extract accurate relative partial-width amplitudes of the analog resonance. (auth)

60179 INVESTIGATION OF NEUTRON-DEFICIENT Cs NUCLEI. Droste, Ch.; Neubert, W.; Chojnacki, S.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; A192: No. 3, 595-608(1972).

Neutron-deficient ^{120,122,123,124}Cs isotopes were studied using Ge(Li) detectors and a magnetic spectrometer installed on-beam with a heavy-ion cyclotron. The isotope ^{123}Cs was obtained in the reactions ^{115}In(^{12}C,4n) and ^{109}Ag(^{18}O,4n) and an isomeric level ($T_{½} = 1.6 \pm 0.2$ s) with 63 and 95.5 keV γ-transitions was found. The isotope ^{124}Cs ($T_{½} = 34 \pm 6$ s) was obtained in the ^{115}In(^{12}C,3n) reaction, and its β^+ decay was studied. The excited levels in ^{124}Cs were studied from the decay of ^{124}Ba. The proposed ^{124}Ba → ^{124}Cs → ^{124}Xe decay scheme is presented. The isotope ^{122}Cs was obtained in the reactions ^{113}In(^{12}C,3n), ^{109}Ag(^{16}O,3n) and ^{109}Ag (^{18}O,5n). The β^+ decay of the isomeric levels ^{122m_1}Cs($T_{½} = 23 \pm 6$ s) and ^{122m_2}Cs($T_{½} = 4.2 \pm 0.4$ min) was studied, and the decay scheme is proposed. The experimental results for ^{122}Cs and ^{124}Cs are compared with theoretical calculations. (auth)

60180 THEORETICAL STUDY OF THE STRUCTURE AND THE ELECTROMAGNETIC PROPERTIES OF ODD–EVEN ANTIMONY NUCLEI. Van Den Berghe, G. J. C. Ghent; Ghent Rijksuniversiteit (1971). 121p. (In Dutch).

Thesis.

Different approximations to describe the energy levels and the electromagnetic properties of nuclei are given. The depth of the Woods–Saxon potential, describing the behavior of the extra proton in odd-even antimony nuclei is determined. The electromagnetic operators are formed, and the transition probability and branching ratios calculated. (Netherlands)

60181 LOW-LYING POSITIVE-PARITY STATES IN ^{101}Tc. Cook, W. B. (McMaster Univ., Hamilton, Ont.); Johns, M. W.; Geiger, J. S.; Graham, R. L. Can. J. Phys.; 50: No. 13, 1511-17(1 Jul 1972). (AECL–4188).

Internal conversion measurement studies of the 14.6 min ^{101}Mo β decay have led to the discovery of the following low-energy transitions in ^{101}Tc: 6.281 ± 0.007 (75.4 ± 9%), 9.317 ± 0.010 (97 ± 1%), and 15.606 ± 0.015 keV (1.9 ± 0.3%). From relative L-subshell intensities, the 6.281 and 9.317 keV transitions are found to be M1 with E2 admixtures of 0.010 ± 0.005% and 0.021 ± 0.006% respectively; the weak 15.606 keV transition is E2 in character. These transitions establish excited states in ^{101}Tc at 9.317 ± 0.010 and 15.601 ± 0.009 keV. The measured multipolarities together with decay scheme considerations lead to J^π values of $\frac{9}{2}$+, $\frac{7}{2}$+, and $\frac{5}{2}$+ for the ground state, the 9.317, and the 15.601 keV states respectively. Since these transitions were not observed in earlier studies of the β decay of ^{101}Mo, quoted decay energies have been 15.6 keV too low. The measured K-conversion coefficient of the 80.926 keV transitions shows that it is M1 with an E2 component of <9%. (auth) (Canada)

60182 RADIOCHEMISTRY. Maddock, A. G. (ed.). MTP International Review of Science. Volume 8. London; Butterworths [(1972)]. 335p. £10.

Separate abstracts were prepared for each of the eight chapters included. (J.W.R.)

For abstracts of individual chapters see: 58640, 59630, 60183–60186, 60222, and 60275.

60183 CHEMICAL APPLICATIONS OF ANGULAR CORRELATIONS AND HALF-LIFE MEASUREMENTS. Vargas, J. I. (Nuclear Chemistry Lab., Grenoble, France). pp 45-70 of Radiochemistry. /Maddock, A. G. (ed.). London; Butterworths (1972).

A brief introduction to the unperturbed angular correlations of γ-rays is given. The various methods of perturbing angular correlations are discussed qualitatively. Some results of measurements made in gaseous, liquid, and solid sources are described. Hot atom effects are examined. The chemical or atomic effects on the various nuclear decay modes are surveyed. (101 references) (J.W.R.)

60184 MEDIUM- AND LOWER-ENERGY NUCLEAR CHEMISTRY. Lefort, M. (Univ. Paris-Sud, Sceaux, France). pp 107-48 of Radiochemistry. /Maddock, A. G. (ed.). London; Butterworths (1972).

After a brief introduction on the scope of nuclear chemistry, sections are included on fundamentals of nuclear reactions, modern experimental methods, compound nuclear reactions, direct transfer reactions, the synthesis of known and unknown nuclei, and applications of nuclear chemistry. (28 references) (J.W.R.)

60185 MOESSBAUER SPECTROSCOPY IN THE STUDY OF THE CHEMICAL EFFECTS OF NUCLEAR REACTIONS IN SOLIDS. Maddock, A. G. (Cambridge Univ., Eng.). pp 213-50 of Radiochemistry. /Maddock, A. G. (ed.). London; Butterworths (1972).

After a brief introduction, sections are included on Moessbauer sources, predicted effects, Moessbauer data, effects following isomeric transitions and electron capture, effects of β decay, and processes with substantial recoil. (212 references) (J.W.R.)

60186 HIGH-ENERGY NUCLEAR CHEMISTRY. Pappas, A. C.; Alstad, J.; Hageboe, E. (Univ. of Oslo). pp 291-335 of Radiochemistry. /Maddock, A. G. (ed.). London; Butterworths (1972).

A review is presented on research in high-energy nuclear chemistry. Topics discussed include models of high-energy nuclear reactions, nuclear structure effects, reaction products, spallation, fission, fragmentation, and reactions producing superheavy elements. (234 references) (J.W.R.)

60187 INELASTIC PROTON SCATTERING FROM ^{138}Ba AND ^{144}Sm AT 30 MeV. Larson, D.; Austin, S. M.; Wildenthal, B. H. (Michigan State Univ., East Lansing). Phys. Lett.; 41B: No. 2, 145-7(18 Sep 1972).

Measurements of the inelastic scattering of 30-MeV protons from ^{138}Ba and ^{144}Sm were carried out with energy resolution of 7 to 10 keV. Differential cross sections were measured for levels up through 3.4 MeV excitation energy. For most of these states J^{π} assignments are suggested on the basis of angular distributions distinctly characteristic of angular momentum transfer L = 2, 3, 4, or 6. (auth)

60188 SYSTEMATICS OF L = 0 TRANSITIONS OBSERVED IN THE (p,t) REACTION OF NUCLEI NEAR N = 50. Ball, J. B. (Oak Ridge National Lab., Tenn.); Larsen, J. S. Phys. Rev. Lett.; 29: No. 15, 1014-17(9 Oct 1972).

Excitation energies and transition intensities were observed for 0^+ states populated by the (p,t) reaction on nuclei near N = 50. Comparison of results on selected isotopes of Sr, Zr, Mo, and Ru shows an unexpected loss of neutron L = 0 transfer strength with increasing proton number. (auth)

60189 DECAY OF ^{107}In AND EXCITED STATES IN ^{107}Cd. Dracoulis, G. D.; Gelletly, W.; Chapman, R.; Mo, J. N.; Hartley, A. J. (Univ. of Manchester, Eng.). Particles Nucl.; 4: No. 1, 42-63(Jul 1972).

The level scheme of ^{107}Cd was investigated in a study of the gamma rays emitted in the β^+/EC decay of ^{107}In. The ^{107}In activity was produced in the ^{107}Ag(^{3}He,3n)^{107}In reaction. High resolution γ-ray singles and coincidence measurements were made with Ge(Li) detectors. A consistent level scheme for ^{107}Cd is proposed and compared with the results of a ^{106}Cd(d,p)^{107}Cd measurement and an intermediate-coupling-model calculation for ^{107}Cd. The level scheme differs substantially from previously proposed schemes. (4 figures, 3 tables) (auth)

Nuclear Properties and Reactions, $150 \leq A \leq 189$

Refer also to abstracts 60108, 60110, 60236, and 60754.

60190 NUCLEAR ORIENTATION OF ^{183}Re AND ^{184}Re IN IRON. Butz, T. (Technische Univ., Munich); Eska, G.; Hagn, E.; Kienle, P.; Umlauf, E. Z. Phys.; 254: No. 4, 312-22(1972).

The temperature dependence of the anisotropy of γ rays from the decay of oriented ^{183,184}Re nuclei situated in an iron matrix was measured between 14 and 33 mK. Magnetic hyperfine splitting constants of $g\ H_{HF} = 5.04\ (9) \times 10^{-18}$ erg and $g\ H_{HF} = 3.21\ (13) \times 10^{-18}$ erg were determined for the ground states of ^{183}Re and ^{184}Re, respectively. With the previously known hyperfine field of −760 (15) kG for Re in iron the following g factors were deduced: ^{183}Re g = 1.32 (5) and ^{184}Re g = 0.84 (5). The E2/M1 mixing ratio of the 793-keV $2^+ - 2^+$ transition in ^{184}W was accurately determined to δ(793 keV) = +16.65 (85). (7 figures, 2 tables) (auth)

60191 THIRD ORDER PERTURBATION TREATMENT OF COULOMB EXCITATION WITH E2 AND E4 INTERACTIONS INCLUDED. Hecking, P.; Winkler, P. (Univ., Erlangen-Nuernberg, Ger.). Z. Phys.; 254: No. 4, 306-11(1972).

For one even-A rotational nucleus (^{152}Sm) a semiclassical third-order perturbation treatment of Coulomb excitation with a hexadecapole interaction included was carried out by considering bombarding conditions which have formerly been found to be suitable for an experimental determination of certain E4 transition moments. Numerical values of the most important contributions to the perturbation hierarchy are given, and the present state of quantal corrections is discussed. (2 figures, 4 tables) (auth)

60192 EVIDENCE FOR HIGHER-ORDER PROCESSES IN SINGLE-NUCLEON TRANSFER REACTIONS. Ascuitto, R. J.; King, C. H.; McVay, L. J. (Yale Univ., New Haven). Contract AT(11-1)-3074. Phys. Rev. Lett.; 29: No. 16, 1106-8(16 Oct 1972).

Anomalies in the shapes of angular distributions with respect to predictions of the distorted-wave Born approximation for several weak transitions in the reactions ^{172}Yb(p,d) and ^{186}W(p,d) are interpreted as resulting from inelastic excitations in the entrance and exit channels. These anomalies are shown to be reproduced when the reactions are treated within the coupled-channel Born approximation. (auth)

60193 α DECAY OF NEUTRON-DEFICIENT ISOTOPES OF BISMUTH AND LEAD PRODUCED IN (Ar,xn) AND (Kr,xn) REACTIONS. Gauvin, H.; Le Beyec, Y.; Lefort, M.; Porile, N. T. (Institut Physique Nucleaire, Orsay, France). Phys. Rev. Lett.; 29: No. 14, 958-61(2 Oct 1972).

Neutron-deficient isotopes of bismuth and lead were produced in various heavy-ion-induced reactions. Argon and krypton ions were used as projectiles on ^{159}Tb, ^{155}Gd, and ^{109}Ag. α emission was observed from bismuth nuclides and isomers with A = 190 to 197 and from lead isotopes with A = 186 to 190. Results on mass assignments, α-decay energies, half-lives, and α branching ratios are given. Two new lead isotopes were found: ^{187}Pb, $E_{\alpha} = 6.08$ MeV, $t_{1/2} = 17.5$ s; and ^{186}Pb, $E_{\alpha} = 6.32$ MeV, $t_{1/2} = 7.9$ s. No α-emitting isotopes of thallium were found, and upper limits significantly below 1% were set on the α branching ratios of Tl isotopes with A = 182 to 187. (auth)

60194 STATES OF ^{165}Tm OBTAINED IN THE REACTION ^{165}Ho(α,4nγ)^{165}Tm. Gizon, J.; Gizon, A.; Hjorth, S. A.; (and others) (Institut des Sciences Nucleaires, Grenoble, France). Nucl. Phys.; A193: No. 1, 193-203(1972). (In French).

The γ-rays following the ^{165}Ho(α,4nγ)^{165}Tm reaction have been studied with Ge(Li) detectors. By means of γ-γ coincidences the rotational bands built on the $1/2^+$[411], $7/2^+$[404], $7/2^-$[523] and $1/2^-$[541] intrinsic states are identified. (auth)

60195 LEVEL STRUCTURE OF ^{151}Pm. Burke, D. G.; Waddington, J. C. (McMaster Univ., Hamilton, Can.). Nucl. Phys.; A193: No. 1, 271-84(1972).

Levels in ^{151}Pm have been populated using the ^{150}Nd(^{3}He,d)^{151}Pm, ^{150}Nd(α,t)^{151}Pm and ^{152}Sm(t,α)^{151}Pm reactions. In each case the outgoing charged particles were analyzed with a magnetic spectrograph and detected with photographic emulsions. Relative spectroscopic factors were obtained by comparing the experimental cross sections with those predicted by DWBA calculations. The results were interpreted in terms of the Nilsson model with Coriolis mixing effects included. The present work confirms the $5/2^+$[413] assignment for the ground state band and the $3/2^+$[411] assignment for the band based on the 255.7 keV level. However, the $11/2^-$ state at 345 keV, previously assigned as the particle state $11/2\ 5/2^-$[532], was found to have a large spectroscopic factor in the pick-up as well as the stripping reactions so this level must have significant admixtures of hole states. Coriolis coupling calculations, carried out with typical parameters, can explain these results by bringing in components of the $3/2^-$[541] and $1/2^-$[550] hole states, which also originate from the $h_{11/2}$ shell. Two other $11/2^-$ states, at ≈640 keV and 782 keV, have also been attributed to strongly mixed configurations although the latter is predominantly the $^{11}/_{2}$ $^{7}/_{2}^{-}[523]$ state. Several positive-parity orbitals with low K-values appear to have their strengths distributed over many states, possibly due to mixing with each other and with nearby vibrational states. (auth)

60196 ROTATIONAL STATES AND CORIOLIS INTERACTION IN ^{171}Yb. Lindblad, Th. (Research Inst. for Physics, Stockholm); Ryde, H.; Barneoud, D. Nucl. Phys.; A193: No. 1, 155-76(1972).

The ^{170}Er(α,3n)^{171}Yb reaction is used to populate rotational states built on the $^{7}/_{2}^{+}[633]$, $^{1}/_{2}^{-}[521]$, $^{5}/_{2}^{-}[512]$ and $^{11}/_{2}^{-}[505]$ intrinsic states. Particular attention is paid to the positive-parity band. The rotational energies within this band are successfully explained within the unified model with pairing and Coriolis interactions included, provided the theoretical Coriolis matrix elements are reduced. With the wave functions obtained from this energy fit the experimental E2/M1 amplitude mixing ratios are well reproduced. These wave functions also reproduce the cross-section pattern obtained in transfer-reaction experiments very well. (auth)

60197 HELIUM ION-INDUCED FISSION OF ^{181}Ta AT 41 AND 65 MeV. Kieburtz, R. D.; Neuzil, E. F. (Western Washington State Coll., Bellingham). J. Inorg. Nucl. Chem.; 34: No. 11, 3303-8(Nov 1972).

A radiochemical study was made of the 41 and 65 MeV helium ion-induced fission of ^{181}Ta. The fission fragment mass distribution curves are Gaussian-shaped but appear to be narrow with values of the width at half-maximum of 2 ± 1 atomic mass units and 4 ± 1 atomic mass units at helium ion energies of 41 and 65 MeV respectively. The total fission cross sections after being corrected for charge distribution effects were approximately 0.1 μ barns and 23 μ barns at the above two energies. (auth) (Australia)

60198 HALF-LIFE OF ^{155}Eu. Subba Rao, B. N. (Tata Inst. of Fundamental Research, Bombay). Curr. Sci. (India); 41: No. 19, 692-4(5 Oct 1972).

A 14-year-old source of ^{155}Eu had a larger activity, as determined in terms of the 105-keV γ intensity than it should have if its half-life were 1.811 ± 0.002 yr as had been previously believed. The earlier value was based on a few months decay curve. Relative γ-ray intensities observed 12 yr apart indicated a half-life value of 4.53 ± 0.14 yr. (L.T.W.)

60199 ROTATIONAL MOTION AT LARGE ANGULAR MOMENTUM IN EVEN-EVEN DEFORMED NUCLEI. Molinari, A.; Regge, T. (Univ., Turin) Phys. Lett.; 41B: No. 2, 93-6(18 Sep 1972).

It is shown that the main features of nuclear rotational motion at large angular momentum can be interpreted on the basis of hybridization of the bands. (auth)

60200 ACCURATE ONE-PARAMETER MODEL FOR ENERGY RATIOS OF YRAST LEVELS OF EVEN NUCLEI TO HIGH SPIN. Draper, J. E. (Univ. of California, Davis). Phys. Lett.; 41B: No. 2, 105-9(18 Sep 1972).

A one-parameter expression with exponential form for the moment of inertia (EXP) is analyzed for ground-state-band rotational energies of levels up to high spin. For ^{168}Yb all transition energies for levels with $I \leq 18$ are correct to 0.1%. Unlike VMI the I increases much more rapidly than ω^2. The model covers the complete range $1 \leq E_4/E_2 \leq 10/3$ without discontinuity. The microscopic meaning of the parameters is given. For ^{162}Er, ^{160}Dy, and ^{158}Dy EXP gives all transition energies with at least 2% accuracy to $\hbar\omega$ = 290 to 300 keV. For these nuclei the EXP stiffness is 13%, 30%, 7%, and 67%, respectively, larger than the VMI stiffness, thus affecting the comparison with microscopic calculations. (auth)

60201 VARIABLE MOMENT OF INTERTIA DESCRIPTION OF BANDS IN ODD-EVEN NUCLEI. Gregory, P. R.; Taylor, T. (McMaster Univ., Hamilton, Ont.). Phys. Lett.; 41B: No. 2, 122-4(18 Sep 1972).

The advantages of extending a variable-moment-of-inertia model to bands in odd-even nuclei are demonstrated. Calculations are performed for bands which are not significantly affected by Coriolis coupling. (auth)

60202 QUADRUPOLE AND HEXADECAPOLE DEFORMATIONS IN RARE-EARTH NUCLEI. Erb, K. A.; Holden, J. E.; Lee, I. Y.; Saladin, J. X.; Saylor, T. K. (Univ. of Pittsburgh). Phys. Rev. Lett.; 29: No. 15, 1010-14(9 Oct 1972).

Electric quadrupole and hexadecapole transition matrix elements were measured in precision Coulomb-excitation experiments with ^{4}He particles for seven even-even targets in the mass range $158 \leq A \leq 170$. The values of the matrix elements $\langle 4^+ || M(E4) || 0^+ \rangle$ determined for ^{158,160}Gd, ^{162,164}Dy, and ^{166,168,170}Er are 0.34 ± 0.11, 0.36 ± 0.10, 0.27 ± 0.10, 0.28 ± 0.11, $0.06^{+0.12}_{-0.18}$, $0.20^{+0.12}_{-0.16}$, and $0.24^{+0.14}_{-0.18}$, respectively. The $\langle 2^+ || M(E2) || 0^+ \rangle$ matrix elements were determined with a typical accuracy of about 1%. Model-dependent β_2 and β_4 deformation parameters are given. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 59898, 60150, 60164, 60166, and 60193.

60203 (COO-3001-18) THREE-PHONON MONOPOLE AND QUADRUPOLE PAIRING VIBRATIONAL STATES IN ^{206}Pb. Flynn, E. R. (Los Alamos Scientific Lab., N. Mex.); Igo, G. J. (California Univ., Los Angeles); Broglia, R. A. (State Univ. of New York, Stony Brook. Inst. for Theoretical Physics. Niels Bohr Institutet, Copenhagen (Denmark)). 7 Aug 1972. Contract AT(11-1)-3001. 18p. Dep. NTIS.

Levels with $J^\pi = 0^+$ and 2^+ are observed in the ^{204}Pb(t,p)^{206}Pb reaction near 6 MeV in excitation energy with cross sections, Q-values, and angular distributions in accordance with the pairing vibrational model prediction. From the experimental data it is concluded that these states have a 4 hole-2 particle character, containing appreciable amplitudes of monopole and quadrupole pairing vibrations. (auth)

60204 DETERMINATION OF PARAMETERS OF THE EFFECTIVE PARTICLE-HOLE INTERACTION IN THE LEAD REGION FROM CONSISTENCY RELATIONS. Nopre, Hugues (Centre de Recherches Nucleaires, Strasbourg); Werner, Ernst. Z. Phys.; 254: No. 4, 345-63(1972).

The implications of translational invariance and gauge invariance for an effective particle-hole interaction of the Migdal type are investigated for ^{208}Pb. It is shown that translational invariance is very well satisfied while the gauge invariance requirement is met rather poorly. Four force parameters are determined from the consistency relations for the two conservation laws. (2 figures, 1 table) (auth)

60205 g-FACTOR OF THE FIRST 2^+ STATE IN ^{192}Pt BY MEASUREMENT OF RECOIL INTO VACUUM. Doubt, H. A.; Fechner, J. B.; Hagemeyer, K.; Speidel, K.-H. (Univ., Bonn). Z. Phys.; 254: No. 4, 339-44(1972).

Perturbed γ-ray angular distributions from the first 2^+ states were measured for Coulomb-excited ^{192,194,196,198}Pt recoiling into vacuum at $v/c = 0.010$. Comparable g factors were obtained for all four nuclei. Normalization to the hyperfine field in ^{196}Pt enabled both a comparison with a recent hydrodynamic g factor measured in ^{192}Pt and a cross-check of disputed Ir in Fe measurements. The following g-factor was obtained: g(316 keV, 2^+; ^{192}Pt) = 0.32(3). (2 figures, 1 table) (auth)

60206 LIFETIME OF THE 0_2^+ STATE OF ^{206}Pb AND THE STATE DEPENDENCE OF THE MONOPOLE EFFECTIVE CHARGE. Tape, J. W. (Univ. of Washington, Seattle); Adelberger, E. G.; Burch, D.; Zamick, Larry. Phys. Rev. Lett.; 29: No. 13, 878-80(25 Sep 1972).

The mean lifetime of the 0_2^+ state of ^{206}Pb was found to be 0.97 ± 0.10 ns. This corresponds to a monopole strength $\rho = (2.6 \pm 0.3) \times 10^{-2}$ and $B(E2 : 0_2^+ \rightarrow 2_1^+) < 2.0\ e^2F^4$. The E0 strength can be accounted for with standard shell-model wave functions by using a state-dependent monopole effective charge derived from isotope-shift data. (auth)

60207 RESONANT PROTON SCATTERING FROM ^{204}Hg. II. Flynn, E. R.; Christensen, P. Rex; Nathan, O.; Fleming, D. G. (Univ. of Copenhagen). Nucl. Phys.; A193: No. 1, 247-56(1972).

The elastic and inelastic 2^+ proton scattering excitation functions were measured from a ^{204}Hg target at bombarding energies from 12.5 MeV to 14.2 MeV and from 16.0 MeV to 18.8 MeV at scattering angles of 150 and 165°. The elastic scattering data show a $T = {}^{45}/_{2}$, $l = 1$ resonance in ^{205}Tl at 12.92 MeV and another possible $l = 1$ resonance at 13.39 MeV, $l = 4$ resonances at 16.98 and 17.40 MeV and $l = 2$ resonances at 16.50, 17.08 and 17.31 MeV. The inelastic scattering to the first excited 2^+ state shows a strong, complicated resonance pattern strikingly similar to the resonance pattern found for the first excited 2^+ state in the ^{208}Pb(p,p′) reaction and having a cross section equal to 2.4 times the ^{206}Pb(2^+) cross section. The elastic data are analyzed to yield resonance parameters: E_{res}, Γ_{total} and Γ_p for each resonance. The observed distribution of g- and d-strength is compared with a recent calculation for ^{205}Hg by Paar. (auth)

60208 USE OF THE PERTURBATED ANGLE $e_{casc}\gamma$-CORRELATION FOR THE ^{197}Hg 133 keV STATE g-FACTOR MEASURING. Kornienko, N. D.; Kul'chinskii, B. G.; Levon, A. I.; Nemets, O. F. (Inst. of Nuclear Research, Kiev). Yadern. Fiz.; 15: No. 4, 637-42(Apr 1972). (In Russian)

The ^{197}Hg 133 keV state g-factor have been measured with a differential angular correlation method. For the first time the $e_{casc}\gamma$ cascade was used for this purpose. The 133 keV state lifetime and g-factor were found to be 8.2 ± 0.3 nsec and 0.45 ± 0.13 correspondingly. This value agrees with one calculated with a mixed-configuration shell model. (auth)

60209 INTERNAL CONVERSION PROCESS OF THE 77 keV TRANSITION IN ^{197}Au. Sahota, H. S. (Punjab Univ., Patiala, India). Indian J. Pure Appl. Phys.; 10: No. 1, 78-9(Jan 1972).

Search for the presence of dynamic nuclear effects in the internal conversion process of the 77-keV transition has been made. Experimental L-subshell conversion intensities have been analyzed in conjunction with the theoretical conversion coefficients without involving any penetration. The investigation confirms the conversion process for this transition to be normal. (auth)

60210 HALF-LIFE ON THE ^{194}Ir DECAY. Geiger, J. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys.; 50: No. 13, 1480-6(1 Jul 1972). (AECL-4185).

The half-life of the ^{194}Ir decay was measured by following the decay of several of the prominent ^{194}Pt γ rays as observed in a series of 254 successive 1 h Ge(Li) γ-ray spectra. The half-life is found to be 19.15 ± 0.03 h, a result in marked disagreement with the most accurately quoted value appearing in the literature. The γ spectra exhibit 45 γ rays which can be identified with transitions in ^{194}Pt. (auth) (Canada)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 58843, 60121, 60154, 60166, 60235, and 60522.

60211 (AD-739731) X-RAYS FROM FISSION. Annual Report, April 1, 1971–March 31, 1972. Richard, Patrick; Moore, C. Fred (Texas Univ., Austin). 31 Mar 1972. Contract N00014-67-A-0126-0012. 49p. NTIS.

The main effort during this part of the contract has been to analyze and write-up the research work performed concerning spontaneous fission of ^{252}Cf. This work involved (x-ray, x-ray) coincidence measurements, (x-ray, gamma-ray) coincidence measurements, (gamma-ray, gamma-ray) coincidence measurements, and the setting up of a fission fragment time-of-flight experiment for determining fission mass yields. (NTIS) (auth)

60212 (LA-5024) CAPTURE CROSS SECTION OF ^{238}Pu FROM PERSIMMON. TABULATION OF VALUES. Silbert, M. G. (Los Alamos Scientific Lab., N. Mex.). Aug 1972. Contract W-7405-eng-36. 27p. Dep. NTIS.

The neutron cross-section measurements carried out in conjunction with the Persimmon nuclear explosion included thin and thick samples of ^{238}Pu. Fission fragment detectors at the thin sample measured the fission cross section of ^{238}Pu. Moxon–Rae (M–R) gamma-ray detectors at the thick sample measured the gamma-ray output, which was proportional to a sum of the fission and capture cross sections of ^{238}Pu. Subtraction of the fission contribution from the M–R signal yielded a measurement of the neutron radiative capture cross section. (auth)

60213 (TID-3317(Suppl.3)) TRANSPLUTONIUM ELEMENTS. A Bibliography. Stuber, C. E. (Technical Information Center (AEC), Oak Ridge, Tenn.). Oct 1972. 126p. Dep. NTIS.

This bibliography comprises 757 references on the transplutonium elements compiled through the period ending March 31, 1972. Part I includes 715 references dealing with the production and chemical, nuclear, and physical properties of elements with Z ≥ 95. The references in this part are grouped by element and arranged chronologically within each group. Part II includes 42 references dealing with the natural occurrence of the transplutonium elements. This collection of references is concerned with attempts to locate or prove the existence of the transplutonium elements in nature. The references are arranged chronologically. An author and subject index are included. (C.E.S.)

60214 ANALYSIS OF ^{134}Cs ISOMER RATIOS IN THE FISSION OF ^{237}Np WITH PROTONS IN THE ENERGY RANGE 20 TO 85 MeV. Rao, C. L.; Yaffe, L. (McGill Univ., Montreal). Can. J. Chem.; 50: No. 12, 1877-81(15 Jun 1972).

An analysis has been made of the isomer ratio, $\sigma_m/(\sigma_m + \sigma_g)$, for ^{134}Cs isomers formed in the fission of ^{237}Np by protons of energies 20 to 85 MeV. Compound nucleus formation was assumed up to a bombarding energy of 50 MeV, with direct interaction as the mechanism at higher energies. Values of the root-mean-square angular momentum of 12h at 20 MeV and 16 to 18h at 60 to 85 MeV bombarding energy agree with the experimental results. The results are consistent with the hypothesis that angular momentum is generated in the fission process. (auth) (Canada)

60215 FERMI AGE OF DELAYED NEUTRONS. Gremm, Otto (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 254: No. 4, 323-38(1972). (In German).

For the first time the migration areas of four single groups of delayed neutrons resulting from the fission of ^{235}U were measured. Values for the migration area M^2, the age $\tau_{\varphi,1.46}$ at the indium resonance, and the age $\tau_{\varphi,th}$ for the slowing down to thermal energies were determined. The values for the age are in good agreement with theoretical values in the literature and with Monte Carlo calculations by means of Bonner-type neutron spectra. (1 figure, 4 tables) (R.W.R.)

60216 SEPARATION OF THE LIGHT PARTICLE IN THE TERNARY FISSION PROCESS. II. Feather, N. (Univ. of Edinburgh). Proc. Roy. Soc. Edinburgh, Sect. A; 69: No. 4, 333-45(1972).

A previous discussion (Feather. Proc. Roy. Soc. Edinburgh 68A 229-244 (1969)) of the energetics of the separation of an α-particle in the ternary fission of an e–e nucleus ($^{236}_{92}$U or $^{252}_{98}$Cf) is generalized to cover the case of a light particle of arbitrary mass and charge separating from a fissioning nucleus the nucleon-parity type of which may be any one of the four possible types. A "profitability index" is defined in terms of which certain broad differences in the light-particle spectra from different types of fissioning nucleus are predicted, and the results of detailed calculations of the minimum energy expense of separation are given for various light particles emitted in the fission of $^{236}_{92}$U and, for comparison, for an α-particle emitted in the fission of $^{238}_{93}$Np, an o–o nucleus. (auth)

60217 SEARCH FOR SUPER-HEAVY ELEMENTS PRODUCED BY SECONDARY REACTIONS IN URANIUM. Westgaard, L. (CERN, Geneva); Erdal, B. R.; Hansen, P. G.; (and others). Nucl. Phys.; A192: No. 3, 517-23(1972).

Thick targets of U were irradiated with 24 GeV protons, the volatile reaction products were isolated from the molten target matrix by vacuum distillation, and finally an electromagnetic isotope separation was performed. Upper limits are set on the production cross section of super-heavy elements decaying by spontaneous fission. The transuranium elements were chemically isolated from the distillation residue and cross sections are given for the production of isotopes of Pu, Am, Cm and Cf. (auth)

60218 DELAYED-NEUTRON YIELDS FROM FISSION OF ^{238}U AND ^{232}Th BY 14.8-MeV NEUTRONS. Benedict, G.; Luthardt, G.; Herrmann, G. (Univ., Mainz). Radiochim. Acta; 17: No. 1, 61-2(May 1972).

Absolute delayed-neutron yields in the 14.8-MeV neutron fission of ^{232}Th and ^{238}U were determined by comparing the neutron and fission rates with the rates in the thermal-neutron irradiation of ^{235}U. The results are compared with predictions and with previous data. (J.W.R.)

60219 DETERMINATION OF THE FISSION YIELD DISTRIBUTION FOR THE FISSION OF ^{241}Am INDUCED BY REACTOR NEUTRONS. Weinlaender, Von W.; Born, H.-J. (Technische Univ., Munich). Radiochim. Acta; 17: No. 1, 18-27(May 1972). (In German).

For the reactor-neutron-induced fission of ^{241}Am the fission yields for a total of 35 masses were determined as against ^{235}U fission yields and compared with available data. The shape of the mass distribution curve was well defined by the measurement points distributed over both mass peaks and the mirror points determined by a special method. For the total number of neutrons emitted a value of approximately 3.0–3.5 is indicated. The characteristic quantities of the distribution function can be classified in familiar schemes. (auth)

60220 ANALYSIS OF THE BINARY AND TERNARY FISSION OF URANIUM INDUCED BY 12.2 GeV PROTONS. Antanasijevic, R.; Todorovic, Z.; Juric, M.; Gerc, V. (Inst. of Physics, Belgrade). Z. Phys.; 254: No. 2, 106-11(1972).

The binary and ternary fission of uranium induced by 12.2-GeV protons was investigated with a polycarbonate detector registering the tracks of particles with mass numbers A > 16. The basic characteristics of binary and ternary fission are discussed and the corresponding cross sections are given. The values of the cross sections for binary and ternary fission are calculated to be σ_B = (915 ± 120) mb and σ_T = (12.8 ± 2.5) mb, respectively. (auth)

60221 AVERAGE NEUTRON YIELD FROM THE SPONTANEOUS FISSION OF ^{249}Bk. Kosyakov, V. N.; Nesterov, V. G.;

Nurpeisov, B.; (and others). At. Energ. (USSR); 33: No. 3, 788-9 (Sep 1972). (In Russian).

Neutron yield studies were conducted with a sample of ^{249}Bk obtained by irradiating a curium target in a reactor. Measurement of $\bar{\nu}$ (^{249}Bk) was based on recording coincidences between pulses of prompt neutrons and fragments of spontaneous fission (ionization chamber) from ^{249}Bk and a standard (^{252}Cf). Assuming $\bar{\nu}$ (^{252}Cf) = 3.756, then $\bar{\nu}$ (^{249}Bk) = 3.395. The latter is somewhat lower than Pyle's value (1957). (K.S.W.)

60222 TRANS-CURIUM ELEMENTS. Silva, R. J. (Oak Ridge National Lab., Tenn.). pp 71-105 of Radiochemistry. /Maddock, A. G. (ed.). London; Butterworths (1972).

The current status of research on the trans-curium elements is surveyed. The nuclear systematics for this region are discussed and experimental decay systematics are compared with recent theoretical results. Methods of production, isolation, and identification are described. Chemical properties of the heavy actinides and light transactinides are discussed. The search for superheavy elements is reviewed. (129 references) (J.W.R.)

60223 RADIATIVE CAPTURE OF NEUTRONS BY ^{238}U IN THE ENERGY RANGE 1.2 TO 4.0 MeV. Panitkin, Yu. G.; Tolstikov, V. A. At. Energ. (USSR); 33: No. 3, 782-3(Sep 1972). (In Russian).

The present article is a continuation of two papers previously published by the same authors during a study of the cross section of radiative capture of neutrons by ^{238}U over a wide energy range. Cross section measurements were conducted at 1.2 to 4.0 MeV by an activation method in a 5-MeV electrostatic accelerator. The neutron source was the reaction T(p,n)^{3}He, and an ionization chamber with a layer of ^{235}U served as the neutron flux monitor. (K.S.W.)

60224 SPECTRUM OF PROMPT NEUTRONS IN THE LOW-ENERGY REGION FOR THE SPONTANEOUS FISSION OF ^{252}Cf. Eki, L. (Central Inst. for Physical Research, Budapest); Kluge, D.; Laitai, A.; D'yachenko, P. P.; Kuz'minov, B. D. At. Energ. (USSR); 33: No. 3, 784-5(Sep 1972). (In Russian).

The neutron spectrum in the 0.002 to 1 MeV region was determined for the spontaneous fission of ^{252}Cf. The energy of the neutrons was derived from their time-of-flight between the layer of ^{252}Cf and the neutron detector. Three types of background were taken into account in the experiment: two components of random coincidence, scattered neutrons, and delayed γ quanta. Most of the work is in satisfactory agreement with that of other workers. (K.S.W.)

60225 NEUTRON YIELD FOR SPONTANEOUS FISSION OF EVEN-EVEN CURIUM ISOTOPES. Prokhorova, L. I.; Nesterov, V. G.; Smirenkin, G. N.; (and others). At. Energ. (USSR); 33: No. 3, 767-70(Sep 1972). (In Russian).

Measurements were performed to determine the average number of prompt neutrons $\bar{\nu}$ per spontaneous fission of ^{244}Cm, ^{246}Cm, and ^{248}Cm. The values obtained are $\bar{\nu}$ (^{244}Cm) = 2.700 ± 0.014, $\bar{\nu}$ (^{246}Cm) = 2.950 ± 0.015, and $\bar{\nu}$ (^{248}Cm) = 3.157 ± 0.015 (cf. $\bar{\nu}$ = 3.756 per spontaneous fission of ^{252}Cf). The dependence of $\bar{\nu}$ on the nucleon content and excitation energy of the fission nucleus is discussed. (auth)

60226 MISSING RESONANCES IN LOW-ENERGY NEUTRON CROSS SECTIONS OF FISSILE NUCLEI. Garrison, John D. (California State Univ., San Diego). Phys. Rev. Lett.; 29: No. 17, 1185-8(23 Oct 1972).

A study of simulated fission cross sections indicates that the number of missed levels for fissile nuclei can be considerably larger than has generally been believed. For a nucleus such as ^{235}U with a number of open fission channels and a small level spacing, approximately half the levels are unobserved at 39 eV neutron energy for a target at room temperature. (auth)

60227 PERTURBATION OF THE ^{235m}U DECAY RATE BY IMPLANTATION IN TRANSITION METALS. Neve de Mevergnies, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Phys. Rev. Lett.; 29: No. 17, 1188-91(23 Oct 1972).

When implanted in transition metals, the decay rate of ^{235m}U is influenced by the free-electron concentration of the host metal. The results can be qualitatively described by means of the "rigid-band" and "screened-potential" models. (auth)

Nuclear Theory

Refer also to abstracts 59393, 59832, 60112, 60135, 60140, 60201, and 60481.

60228 (AD-739362) PREDICTED PARAMETER UNCERTAINTIES FOR LEAST-SQUARES ANALYSIS OF A SINGLE EXPONENTIAL DECAY WITH A CONSTANT-BACKGROUND RATE. Rodeback, G. W. (Naval Postgraduate School, Monterey, Calif.). 25 Nov 1971. 19p. (NPS-61-RK-71111-A). NTIS.

The decay constant and initial activity for a single exponential decay, together with a constant background activity, are assumed to be the three adjustable parameters for a least squares fit of experimental data. The expected variances of these three parameters are predicted mathematically for the general case where it is assumed that experimental decay counts with inherent statistical uncertainty are collected in successive equal time intervals of negligible uncertainty. Comparisons of a parameter uncertainty with respect to the time interval, number of intervals and background activity are based on a fixed "confidence interval" for the parameter. Assumed background rates are expressed as fractions of the initial decay activity. The results can be simply applied to arbitrarily assumed values of decay constant and initial activity. (auth)

60229 (AD-739921) COMPUTER CODES AVAILABLE FOR ANALYSIS OF DIRECT NUCLEAR REACTIONS. Park, Yong S.; Jones, Heber D. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Mar 1972. 38p. (BRL-MR-2164). NTIS.

The report is a documentation of computer codes available at BRL for the analysis of direct nuclear reactions. It has been generated as a detailed supplement to the existing instruction manuals, which, where available, provide only very general information on code applications. In the report, emphasis is placed on additional options which have been incorporated into the original programs to enhance their applicability to the types of experiments performed at this laboratory. Sample input and output for local users are presented to clarify the utilization of the codes in situations of interest to experimenters at BRL. (auth) (NTIS)

60230 (JAERI-M-4576) NECESSITY OF A COMPUTER SYSTEM IN THE FIELD OF NUCLEAR DATA. Asami, Tetsuo; Igarashi, Shinichi; Okamoto, Koichi; Kato, Kazuaki (Japan Atomic Energy Research Inst., Tokyo). Sep 1971. 36p. (In Japanese). NTIS (U. S. Sales Only).

Various works in the field of nuclear data to which the use of computer system is requisite are reviewed to find the necessary conditions for the system. The utilizations of the computer, rather than its specifications, are investigated in detail. (auth)

60231 (LBL-549) FISSION AND FUSION DYNAMICS. PART I. Swiatecki, W. J. (California Univ., Berkeley. Lawrence Berkeley Lab.). 2 Dec 1971. Contract W-7405-eng-48. 13p. (CONF-710559-1). Dep. NTIS.

From Ebeltoft conference; Ebeltoft, Denmark (19 May 1971).

Nuclear fission and heavy-ion fusion reactions are discussed in a unified theory. A macroscopic approach is used in formulating a dynamical theory of these processes. The potential energy, damping, and inertial terms in the equations of motion are examined. The important features in the smooth part of the potential are emphasized. Possibilities for heavy-ion fusion reactions are discussed. (J.W.R.)

60232 (NP-19356) DIRECT REACTION THEORY. (Bergen Univ. (Norway). Dept. of Physics). 1971. 93p. (In Norwegian). Dep. NTIS (U. S. Sales Only).

The report represents the transcript of a lecture series presented during the spring semester 1971 at the Institute of Physics of the University of Bergen. The subjects treated include the following: Elastic scattering, definition and calculation of cross sections, scattering experiments; integral representation of the scatter amplitude, the Born approximation; distorted-wave Born approximation for elastic scattering; General scattering theory, multichannel scattering, the optical potential, application of the distorted wave Born approximation for (d,p) reactions, anti-symmetrization and spectroscopic applications of the stripping reaction. (TTT)

60233 (ORO-4317-13) STATISTICAL MODEL OF INTERMEDIATE STRUCTURE. Technical Report No. 73-011. Lee, Edward V.; Griffin, James J. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Jul 1972. 40p. Dep. NTIS.

The predictions of the statistical model of intermediate structure are compared with experimental data and with other statistical reaction theories. The systematic development of the statistical model of intermediate structure is traced. Some precompound emission probabilities are derived and compared with the Weisskopf evaporation theory and the Fermi-gas model. (J.W.R.)

60234 (ORO-4317-15) THEORETICAL STUDIES IN NUCLEAR REACTION AND NUCLEAR STRUCTURE. Progress Report, September 1, 1971-September 1, 1972. MacDonald, W. M.; Banerjee, M. K. (Maryland Univ., College Park. Dept. of Physics and Astronomy). 1972. Contract AT(40-1)-4317. 34p. Dep. NTIS.

Theoretical research in the areas of nuclear structure and properties, nuclear reactions and scattering, fission, the nucleon–nucleon interaction, the three-body problem, interactions of pions with nucleons and nuclei, and quantum electrodynamics of strong fields is briefly reported. (J.W.R.)

60235 EFFECT OF SPURIOUS MOTION ON THE COLLECTIVE POTENTIAL ENERGY SURFACE. Kolb, D.; Fink, B.; Scheid, W. (Univ., Frankfurt am Main). Z. Phys.; 254: No. 4, 293-305(1972).

Energy corrections to the potential energy surface which are caused by spurious collective motions are investigated; spurious center-of-mass motion, rotational oscillations, and spurious vibrations are emphasized. It is shown that the effects are deformation dependent and, thus, that the heights and curvatures of the potential energy surface are changed. The changes are of the order of 1 to 2 MeV in the range of deformation $\delta = 0$ to $\delta = \pm 0.4$. (3 figures) (auth)

60236 EXCITATION FUNCTION AND ISOMER RATIOS FOR HEAVY-ION-INDUCED REACTIONS. Sperber, D. (Rensselaer Polytechnic Inst., Troy, N. Y.). Nuovo Cim.; 11A: No. 2, 380-8(21 Sep 1972).

A method for the calculation of excitation functions and isomer ratios in heavy-ion–induced reactions is developed. The method is applied to the calculation of the excitation function and isomer ratio for the reaction Dy(^{40}Ar,xn)Po. Calculated values are compared with experiment. (2 tables) (auth)

60237 CONSERVING APPROXIMATIONS IN NUCLEAR PHYSICS. Letourneux, J.; Padjen, R. (Univ. of Montreal). Nucl. Phys.; A193: No. 1, 257-70(1972).

The construction of conserving approximations going beyond the random phase approximation is discussed in the framework of Baym and Kadanoff's formalism. In particular, the possibility of formulating a conserving approximation starting from a variational HF calculation performed with a density-dependent effective interaction is examined. It is shown that even if Baym and Kadanoff's diagrammatic method cannot be applied directly in that case, a general prescription given by Baym enables one to determine the form of the effective particle-hole interaction which should be used in such a calculation. (auth)

60238 REDUCTION OF THE PROBLEM OF REARRANGEMENT REACTIONS TO A PAIR OF TWO-PARTICLE PROBLEMS. Dolinszky, T. (Central Research Inst. for Physics, Budapest). Nucl. Phys.; A193: No. 1, 43-8(1972).

The general Humblet–Rosenfeld formula of the collision matrix is applied in order to extend Feshbach's theory of the optical potential to rearrangement reactions. Integral equations are set up for the projections of the scattering state onto both the input as well as the output channels, and the problem of their relative normalization is solved. The solution of these two optical problems is found to be equivalent to the calculation of the transition matrix element for the reaction. (auth)

60239 ROTATIONAL STATES IN LIGHT NUCLEI. Bouten, M. (SCK/CEN, Mol, Belgium); Bouten, M. C.; Caurier, E. Nucl. Phys.; A193: No. 1, 49-59(1972).

Some properties of the projected Hartree–Fock functions which describe the ground state bands in ^{8}Be, ^{12}C and ^{20}Ne, and the excited 8p–8h band in ^{16}O are studied in order to answer the question whether these states correspond to real rotational motion in these light nuclei. (auth)

60240 CALCULATION OF MOMENTS OF INERTIA AND GYROMAGNETIC RATIOS INCLUDING RESIDUAL p–h AND p–p INTERACTION. Meyer, J. (Technische Univ., Munich); Speth, J.; Vogeler, J. H. Nucl. Phys.; A193: No. 1, 60-4(1972).

Moments of inertia and g_R factors of even rare-earth nuclei are calculated taking into account the corrections coming from residual p-h and p-p interactions. It is shown that there is a strong "first-order" anti-pairing effect on the moment of inertia which nearly cancels the effect of the p-h interaction. (auth)

60241 ROLE OF THE GAS-LIQUID PHASE TRANSITION IN THE THEORY OF NUCLEAR MATTER. Ramirez, S.; De Llano, M. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys.; A193: No. 1, 81-96(1972).

A sufficient condition for the two-nucleon interaction to produce a gaseous instability in the form of the appearance of inhomogeneous-spatial-density single-particle states of lower energy than the (homogeneous) plane-wave states is found to be simply that it gives binding in first order. The critical density at which the instability occurs thus signals the unambiguous breakdown of a plane-wave-based Hartree-Fock perturbation expansion for the ground state properties. Several examples are analyzed. (auth)

60242 DIRECT REACTIONS TO MANY-CHANNEL MANY-LEVEL FINAL STATES AND AN EXAMPLE: (d,p) FISSION. Treacy, P. B. (Australian National Univ., Canberra). Nucl. Phys.; A193: No. 1, 97-112(1972).

The cross section for a direct reaction to a decaying final state is calculated using an R-matrix expansion for the final-state wave function. The theory is applied to a (d,p) reaction to a fissioning nucleus, with a simple two-center fission model. Data from the ^{239}Pu(d,pf) process are fitted; the results imply that the usually accepted two-hump potential shape may need modification. (auth)

60243 DWBA FOR INELASTIC NUCLEON SCATTERING WITH VELOCITY-DEPENDENT FORCES. Boridy, Elie; Pearson, J. M. (Univ. of Montreal). Nucl. Phys.; A193: No. 1, 113-28(1972).

Satchler's microscopic formulation of the DWBA for inelastic scattering is extended to include a quadratic momentum (p^2) dependence in the central part of the two-body force. The expressions are valid for arbitrary projectiles. In principle a p^2 term permits the excitation of abnormal-parity states without spin flip, a process which was previously shown to be important in α-scattering. However, in the case of nucleon scattering, it is shown here, by considering the 2^- state at 8.88 MeV in ^{16}O and the 3^+ state at 3.414 MeV in ^{58}Ni, that the usual spin-flip mechanism generally dominates the excitation of abnormal-parity states. Furthermore, even though [illegible] force can make a large contribution to the spin-flip term, its effect there could probably always be simulated phenomenologically by some equivalent static force. (auth)

60244 USE OF THE VARIATIONAL PRINCIPLE IN NUCLEAR PHYSICS. Tarr, Paul W. (Univ. of Idaho, Moscow). Nucl. Phys.; A193: No. 1, 177-85(1972).

The most general form of the variational principle, which treats all of the observables of a system on an equal basis, is formulated. The Hartree–Fock equations and the "projected" variational equations are shown to be special cases of the general formulation. A new expression for the moment of inertia and an additional contribution to the spin-orbit interaction of the shell model are obtained. A generalization to include singular forces is indicated. (auth)

60245 KANTOR AMPLITUDES OF NUCLEON–NUCLEON SCATTERING BELOW 500 MeV. Furuichi, S. (Rikkyo Univ., Tokyo); Suemitsu, H.; Yonezawa, M.; Watari, W. Nucl. Phys.; A193: No. 1, 285-96(1972).

Using the presently available data of nucleon-nucleon scattering phase shifts, the Kantor amplitudes below 500 MeV are calculated. Comparison is made for some models of the nucleon-nucleon interaction with the newly obtained Kantor amplitudes. (auth)

60246 CENTRE-OF-MASS MOTION IN THE ANHARMONIC OSCILLATOR. Hilton, R. R. (Hacettepe Univ., Ankara). Nucl. Phys.; A193: No. 1, 297-304(1972).

An investigation of the spurious cm motion in the anharmonic oscillator is undertaken using a collective-intrinsic description of the system. Criteria are established which demonstrate the validity of the form of the collective Hamiltonian and separability condition used for the cm motion in the formalism. The effective inertial parameter associated with the cm motion is extracted and shown to have an upper bound given by the pushing model. The method is used to furnish the inertial parameter for independent fermions in a highly deformed Nilsson well; the resulting effective mass which decouples the cm motion is shown to depend on the direction of motion. (auth)

60247 PHOTONUCLEAR REACTIONS FROM CORRELATED NUCLEON PAIRS. II. Bramanis, Egons (Univ. of Melbourne). Nucl. Phys.; A193: No. 1, 323-36(1972).

A derivation of an expression for the cross section of the photoexcitation of correlated nucleon pairs in a nucleus is given. The final-state wave functions which are obtained from a solution of the Brueckner reaction matrix can be related to the scattering of free nucleons in a vacuum. Some results are presented and include the energy distribution and cross sections of the excited nucleons. An expression for the cross section of the giant dipole resonance is derived purely from the presence of the microscopic two-body forces in nuclei. These cross sections agree with experiment for a particular choice of the final-state single-particle spectrum. (auth)

60248 EXCITED STATES OF A THREE-PARTICLE SYSTEM. Tuskiya, V. G.; Chilashvili, G. A. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR; 67: No. 2, 325-8(Aug 1972). (In Russian).

The problem of the excited state of a three-particle system is
considered. An analysis is carried out for specific nu
shown that if a nonlocal separable potential does not sa
Faddeev conditions, some of the excited states may be qu
A specific example is presented to show the validity of the
effect". (auth)

60249 NUMERICAL COMPARISON OF REACTION-MATRIX AND JASTROW METHODS FOR NUCLEAR MATTER: A REASSESSMENT. Baeckman, S.-O. (Institutionen foer Fysik, Abo, Finland); Clark, J. W.; Ter Louw, W. J.; Chakkalakal, D. A.; Ristig, M. L. Phys. Lett.; 41B: No. 3, 247-50(2 Oct 1972).

It is demonstrated by two numerical examples that in Jastrow theory a treatment of three-hole-orbital contributions in harmony with the usual practice of Brueckner–Bethe–Goldstone theory can be quite unwise for sizeable values of the wound parameter. (auth)

60250 INFLUENCE OF ELASTIC TRANSFER ON THE IMAGINARY PART OF HEAVY-ION OPTICAL POTENTIALS. Fuller, R. C.; McVoy, K. W. (Centro de Investigacion y de Estudios Avanzados del IPN, Mexico City). Phys. Lett.; 41B: No. 3, 257-8(2 Oct 1972).

The optical potential for the elastic scattering of a pair of heavy ions may contain a Majorana component, in both its real and imaginary parts. A simple argument is advanced which indicates that such a component is to be expected whenever the difference between the masses of the two nuclei is a small fraction of the mass of either one. (auth)

60251 TALMI INTEGRALS AND EFFECTIVE INTERACTION. Hasse, R. W. (Univ., Heidelberg); Waghmare, Y. R. Phys. Lett.; 41B: No. 3, 264-6(2 Oct 1972).

Contributions due to central, spin–orbit, and tensor forces to various two-particle effective interactions are separated and expressed as a sum of Talmi integrals. From the approximate knowledge of these integrals the radial dependence of the effective interactions of light nuclei is extracted. (auth)

60252 COMPARISON OF THE PAIRING TENDENCIES OF THE T = 1 AND T = 0 INTERACTIONS. Sharma, S. K.; Bhatt, K. H. (Physical Research Lab., Ahmedabad, India). Phys. Lett.; 41B: No. 3, 287-90(2 Oct 1972).

The T = 1 interaction is not found to be substantially more "pairing" in character than the T = 0 interaction. (auth)

60253 NOTE ON THE TREATMENT OF THE PROJECTION-OPERATOR IN THE NUCLEAR G-MATRIX EQUATION. Pradhan, H. C. (McMaster Univ., Hamilton, Ont.). Phys. Lett.; 41B: No. 3, 281-2(2 Oct 1972).

An alternative derivation of the new solution for the nuclear G matrix obtained by Tsai and Kuo is presented. (auth)

60254 POSSIBILITY OF MASS SEPARATION UTILIZING MULTIPLE NUCLEAR SCATTERING AT HIGH ENERGY. Biswas, N. N. (Univ. of Notre Dame, Ind.). Phys. Rev., D; 6: No. 7, 1927-9(1 Oct 1972).

It is found that the dispersion of a beam of high-energy particles in passing through a medium is dominated by multiple nuclear scattering and is mass-dependent. This leads to the possibility of mass separation of a momentum-analyzed beam of charged particles. The feasibility of such a separation is discussed. (auth)

60255 MULTIPLE-STEP PRODUCTION MODEL FOR COHERENT REACTIONS ON NUCLEI. Bochmann, G. V. (Univ. of Montreal). Phys. Rev., D; 6: No. 7, 1938-42(1 Oct 1972).

A model is described for coherent particle production and scattering on nuclei at high energy using the hypothesis of additivity of the phase shifts from the reactions with individual nucleons. This model describes multiple-step processes and the effect of longitudinal momentum transfer. It is shown that this model is equivalent to the eikonal solution of a multichannel optical model, up to corrections of the order 1/A. The effect of the two-body interaction range and of the correlations in the nuclear density distribution is discussed in the general case of coherent reactions. Generalizations of results that have been known for the case of elastic scattering on nuclei are found. The Appendix describes a general purpose program for the calculation of coherent and incoherent production reactions on nuclei. (auth)

60256 APPLICATION OF THE LEAST SQUARE METHOD IN THE ANALYSIS OF EXPERIMENTAL DECAY CURVES. Prouza, Z.; Rakovic, M. (Charles Univ., Prague). Isotopenpraxis; 8: No. 3, 111-13(Mar 1972).

A mathematical procedure for analyzing decay curves, based on the least-square method, was developed and the analysis of the two-component curve was presented as an example. The precision of the method was evaluated depending on the following factors: total time measuring the curve, number of experimental points, representation of individual components, and ratio between half-lives. The method is capable to resolve individual activities even in the case of unfavorable half-life ratios. (auth)

60257 FOLDED YUKAWA NUCLEAR SINGLE PARTICLE POTENTIAL WITH TWO CENTRES. Ohta, Kohichi (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 6, 2144-6(Jun 1972).

A two-center potential appropriate for use in numerical calculations of properties of two interacting nuclei is proposed. The momentum- and spin-independent part of the potential is given by folding the Yukawa function with strength v_0 and range μ: $v(\vec{r}) = -(v_0/4\pi)\int d\vec{r}\,'(e^{-|\vec{r}-\vec{r}\,'|/\mu}/|\vec{r}-\vec{r}\,'|)$ where the integration is over the two spheres with radii R_1 and R_2 and the relative distance R of the two centers at $z = z_1$ and z_2 (i.e., $R = z_1 - z_2$). (L.T.W.)

60258 CALCULATED CROSS-SECTIONS FOR THE ^{141}Pr $(\gamma,\pi^- n)^{140}$Nd AND ^{141}Pr$(\gamma \pi^- 2n)^{139}$Nd REACTIONS. Diefallah, El-Hussieny M. (Assiut Univ., Egypt). Indian J. Pure Appl. Phys.; 10: No. 1, 77-8(Jan 1972).

Nuclear reaction excitation functions have been calculated for ^{141}Pr $(\gamma,\pi^- n)^{140}$Nd and ^{141}Pr $(\gamma,\pi^- 2n)^{139}$Nd reactions. Cross sections of photopion production have been correlated with the elementary photopion production from hydrogen nuclei by assuming an $A^{1/3}$ dependence. Use has been made of Weisskopf's compound-statistical model to calculate the probability of evaporation of one or two neutrons from the residual nucleus excited by the recoil proton from pion production. The energies of the recoil protons have been calculated making use of the earlier calculated values of differential cross sections. (auth)

60259 APPLICATION OF STEENBERG'S MODEL TO THE SCATTERING OF 19.3 GeV/c PROTONS FROM ^{9}Be NUCLEI. Rashmirekha; Tuli, S. K. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys.; 10: No. 1, 26-8(Jan 1972).

An application of Steenberg's model of high energy nuclear scattering to the case of protons of momentum 19.3 GeV/c scattering from a target of ^{9}Be nuclei is reported. The differential scattering cross section for nuclear scattering is calculated and the contribution from Coulomb scattering is estimated. The computed differential scattering cross sections compare favorably with the experimental data of G. Belletini et al. [Nucl. Phys., 79 (1966), 609]. The results are interpreted in the light of the scope and limitations of the model. (auth)

60260 EFFECTS OF FINITE NUCLEAR DIMENSIONS IN HIGHEST APPROXIMATIONS IN THE THEORY OF INTERNAL CONVERSION. Kuzhyr, P. R. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 6, 104-9 (1971). (In Belorussian).

The theory of internal conversion, allowing for the highest approximations, was generalized for the case of finite dimensions of the nucleus. Using ^{181}Ta as an example, calculation of the dynamic effect of the finite dimensions of the nucleus may change considerably the value of the effect of the "electron bridge" in the case of delayed γ transitions. Numerical evaluation of the magnitude of the effects of the highest approximations were made for Z = 94 on the M_{III}, M_{IV}, and M_V-subshells. (tr-auth)

60261 NOTE ON THE ADLER–ADLER RESONANCE FORMALISM. Cook, J. L. (Australian Atomic Energy Commission Research Establishment, Sutherland). Aust. J. Phys.; 25: No. 3, 247-52(Jun 1972). (AAEC/TM–606).

Over restricted energy ranges, the Adler–Adler method of parameterizing resonance cross sections is in general the exact result of inverting the channel matrix. This provides a simple analytical form for the cross section which can be used in reactor physics calculations. (auth)

60262 METHOD FOR INVERTING THE CHANNEL MATRIX IN R-MATRIX THEORY. Bertram, W. K. (Australian Atomic Energy Commission Research Establishment, Sutherland). Aust. J. Phys.; 25: No. 3, 253-8(Jun 1972). (AAEC/TM–607).

A technique is presented for inverting the channel matrix which occurs in R-matrix theory. The collision matrix is expressed in a form which does not involve matrix inversions; it is evaluated by the application of a recurrence relation. The connection between this method and the level matrix formalism is examined. (auth)

60263 STATIC AND TIME-DEPENDENT PERTURBATIONS ON NUCLEAR ANGULAR CORRELATIONS. Lopez-Garcia, Alberto (Univ., Bonn). Z. Phys.; 253: No. 3, 187-90(1972).

The case of static and statistical perturbations for $\tau \ll \tau_N$ is considered in a general form. The resulting Bloch–Wangness–Redfield equation is solved by means of the Laplace transform. A derivation of the time-differential and time-integrated attenuation factor is presented. (auth)

60264 GAMMA-RAY ANGULAR CORRELATIONS PERTURBED BY A STOCHASTIC GAUSSIAN–MARKOV PROCESS. Bosch, F.; Spehl, H. (Univ., Freiburg i. B.). Z. Phys.; 253: No. 3, 257-68(1972).

Perturbed angular correlation attenuation coefficients are given for randomly fluctuating extranuclear fields in the "Fixed Orientation Gaussian Approximation" (FOGA). The fluctuating field is regarded as a stochastic Markov process with Gaussian probability distribution of the field strengths. The results are applicable to any correlation time. (auth)

60265 NON-LOCALITY OF MULTIPLE-SCATTERING CORRECTIONS TO THE NUCLEON—NUCLEUS OPTICAL POTENTIAL. Johnson, Ronald C.; Martin, D. C. (Univ. of Surrey, Guildford, Eng.). Nucl. Phys.; A192: No. 3, 496-516(1972).

The Watson multiple-scattering theory is used to generate the first- and second-order optical potentials for nucleon—nucleon elastic scattering at intermediate and high energies. A method is developed for treating exactly the non-locality of the second-order potential and the scattering from the exact calculation is compared to that from a local approximation for the second-order potential. The results are significantly different both for the angular distributions and the polarization. (auth)

60266 ODD-MULTIPOLE SHAPE DISTORTIONS AND THE FISSION BARRIERS OF ELEMENTS IN THE REGION $84 \leqq Z \leqq 120$. Moeller, P. (Univ. of Lund, Sweden). Nucl. Phys.; A192: No. 3, 529-80(1972).

Potential-energy surfaces have been studied for a large number of nuclei in the region $84 \leqq Z \leqq 120$. The shapes of the studied nuclei correspond to a continuous sequence from a spherical shape to distortions slightly beyond the outer saddle taking into account both symmetric and asymmetric deformations. The effect of asymmetric distortions is studied in detail. It is found that the second saddle of the actinide elements is asymmetrically distorted. The size of the asymmetry is a sensitive function of the neutron number and generally of the position of specific orbitals in the single-particle energy level diagrams. The amount of asymmetric distortions at the outer saddle is also well correlated to the experimental mass ratios in low-energy or spontaneous fission. From the calculated potential-energy surfaces fission-barrier parameters are determined for some 50 nuclei in the region. Results pertinent to the superheavy region indicate that the barrier heights are not reduced by taking asymmetric distortions into account in the calculations. From the potential-energy surfaces obtained it seems probable that the mass distribution of the fission products is symmetric for superheavy elements near $Z = 114$, $N = 184$. (auth)

60267 NON-PAIRING ASPECTS OF THE $T = 1$ INTERACTION. Sharma, S. K.; Bhatt, K. H. (Physical Research Lab., Ahmedabad, India). Nucl. Phys.; A192: No. 3, 625-40(1972).

Emphasis is generally placed on the pairing nature of the $T = 1$ interaction, while at the same time considering the $T = 0$ interaction, to play an important role in producing deformation. Contrary to this, it is shown that the $T = 1$ component of the effective interaction in the 2p-1f shell has a multipole character almost similar to that of the $T = 0$ component. However, some evidence is presented which indicates a slightly greater pairing tendency of the $T = 1$ component. The quadrupole dominance of the interaction in both the $T = 0$ as well as the $T = 1$ channels is demonstrated. It is then shown that the enhanced pairing effects in the 2p-1f shell are largely due to a somewhat unfavorable sequence of experimental single-particle energies. Further, it is found that the Pauli principle has a strong effect on the magnitude of the deformation that an interaction can produce. (auth)

60268 EFFECT OF COMPLEX COUPLING IN INELASTIC CROSS SECTIONS, ASYMMETRIES, AND SPIN FLIP IN THE DWA. Howell, R. H.; Hammerstein, G. R. (Michigan State Univ., East Lansing). Nucl. Phys.; A192: No. 3, 651-7(1972).

The effects of adding an effective imaginary part to real inelastic microscopic form factors in DWA are investigated. Calculations are compared to data for the proton differential cross sections and asymmetries of the lowest-lying states of ^{120}Sn, ^{58}Ni, and ^{208}Pb. Proton spin flip is calculated for ^{120}Sn. Both collective imaginary and effective microscopic imaginary contributions were considered. The most substantial improvements were in fits to asymmetry data. Collective-model calculations indicate the effects of complex coupling are comparable to those of the deformed spin-orbit well. (auth)

60269 SEPARABLE ENERGY-DEPENDENT APPROXIMATION TO LOCAL POTENTIALS. Bhatia, Ravi P.; Walker, James F. (Univ. of Massachusetts, Amherst). Nucl. Phys.; A192: No. 3, 658-72(1972).

An extension of the single-pole separable approximation of a two-body t-matrix in which the effects of several poles are included is made. The simple form for the t-matrix derived from a single separable potential is retained. However, the separable potential is constructed using an energy-dependent superposition of the states corresponding to the various poles. The energy dependence is chosen so as to obtain the correct residue of both the on-shell and off-shell t-matrices at each of these poles, while preserving unitarity. The formalism is specialized to the case of s-wave scattering from an attractive square well. Comparison to the exact s-wave cross section gives good results. (auth)

60270 APPLICATION OF THE GROSS THEORY OF β DECAY TO DELAYED-NEUTRON EMISSIONS. Takahashi, Kohji (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 47: No. 5, 1500-16(May 1972).

Delayed neutron emission is investigated theoretically. First, the strength functions for the allowed and first-forbidden β-decays of delayed neutron precursors are calculated by the gross theory of β-decay developed by Takahashi, Koyama and Yamada. It is shown that the strengths obtained by the sum rule considerations of the gross theory are less energy-dependent than those used by other investigators. Next, the absolute magnitudes of the delayed neutron emission rates are calculated for the first time without taking into account the angular momentum. The general trends of the observed emission rates for many nuclides can be well explained. Furthermore, the energy spectra of delayed neutrons are calculated for several examples in consideration of the angular momentum. These results show that the gross theory of β-decay is favorably applicable to the study of delayed neutrons. (auth)

60271 STUDY OF α CHAIN STATES THROUGH THEIR DECAY WIDTHS. Suzuki, Yasuyuki; Horiuchi, Hisashi; Ikeda, Kiyomi (Tokyo Univ. Kyoto Univ. Niigata Univ., Japan). Progr. Theor. Phys. (Kyoto); 47: No. 5, 1517-36(May 1972).

The structure of the peculiar excited levels in ^{12}C and ^{16}O are investigated by analyzing the decay widths of these levels which have been usually assumed to have the linear chain-like structure of the α particles. In the analyses of the decay widths, all the two body breakup channels are taken into considerations. The theoretical calculations of the reduced width amplitudes are done by using the Bloch—Brink type wave functions. For ^{12}C, the comparison between the theory and experiments showed that the pure linear chain configuration is inappropriate to explain the large experimental widths. On the other hand, for ^{16}O, the present experimental information on widths is understood not to be inconsistent with the assumption of the linear chain structure. (auth)

60272 ALPHA-LIKE SPATIAL FOUR-BODY CORRELATIONS IN LIGHT NUCLEI. VERTICALLY-TRUNCATED-SUBSPACE SHELL MODEL FOR THE CORE PLUS FOUR-PARTICLE SYSTEM. Kamimura, Masayasu; Matsuse, Takehiro; Takada, Kenjiro (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 47: No. 5, 1537-62(May 1972).

Spatially correlated modes of the extra four particles in the core plus four-particle system are investigated on the basis of the (major-shell-mixing) shell-model picture. New bases of the four-body configurations are introduced to represent both the shell-model character and the α-like-clustering nature of the four particles. The bases define a subspace in which the single-particle shell-model states are vertically truncated with the [4] symmetry. The model is applied to the study of the low-lying even-parity levels of ^{20}Ne, reproducing well the levels in the ground band with the use of the residual interaction much weaker than that used in the sd shell model. Spatial correlations and higher-shell-mixing effects in the calculated states are investigated from the various viewpoints. (auth)

60273 PHASE TRANSITIONS IN NUCLEAR FISSION. II. Ohta, Kohichi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 5, 1563-92(May 1972).

The nucleus immediately after the second saddle point in a dumbbell structure is described in terms of two nuclear clusters linked by quasiparticle exchange. The itinerant quasiparticles near the Fermi surface are designed to resolve the inconsistency between the alternative models of nuclear fission, the shell model and the cluster model. The effective residual interaction operative between quasiparticles comprises long-range and short-range parts, the former originating from the exchange coupling of the two forming clusters and the latter from the pairing interaction. The condensed state at low excitation energies is then characterized by the corresponding order parameters, mass asymmetry between two clusters and the energy gap in the single-quasiparticle excitation spectrum. Each order parameter displays a continuous behavior at a transition point, indicating a phase transition of the second kind. In the condensed phase, short-range order carries on an active competition against long-range order. Under certain conditions there occurs saturation mass asymmetry in the ground state which leads to the production of the closed shell fragment. A discussion is devoted to the current-carrying state which may play a role in fission and furnish an explanation of the mass asymmetry. (auth)

60274 ROLE OF THE ADJUSTABLE PARAMETER Q_c OCCURRING IN THE RESONANCE THEORY. Sharma, H. C.; Kulkkarni, A. B.; Nath, N. (Kurukshetra Univ., India). Progr. Theor. Phys. (Kyoto); 47: No. 5, 1797-9(May 1972).

The role of the parameter Q_c in the Moldauer theory of resonance nuclear reactions is examined. Some conclusions regarding the magnitude of Q_c are drawn. (J.W.R.)

60275 NUCLEAR FISSION. Walton, G. N. (Imperial Coll. of Science and Tech., London). pp 1-44 of Radiochemistry. /Maddock, A. G. (ed.). London; Butterworths (1972).

A survey on the current status of fission theory and research is presented. After a brief introduction, more detailed sections are included on spontaneous fission isomers, shell structure effects, comparison of fission theories, ternary fission, and post-fission phenomena. (80 references) (J.W.R.)

60276 SPIN FLIP IN INELASTIC SCATTERING: A POSSIBLE EXPLANATION OF THE OBSERVED BACKWARD-ANGLE PEAK. Moss, J. M. (Univ. of Minnesota, Minneapolis). Phys. Lett.; 41B: No. 3, 244-6(2 Oct 1972). (COO-1265-122).

By utilizing an analogy between the spin—orbit field and a magnetic dipole in a magnetic field, it is shown that a plane-wave Born-approximation calculation in two dimensions gives a good qualitative account of the observed features of the probability of spin flip in inelastic scattering. Comparisons of the two-dimensional model and the collective model DWBA are given for the reaction ^{58}Ni(p,p′)^{58}Ni(2^+) at 20 MeV and 100 MeV. (auth)

60277 GRAPHS AND GLAUBER. Bertocchi, L. (Univ., Trieste, Italy). Nuovo Cim.; 11A: No. 1, 45-62(1 Sep 1972).

Gribov's derivation of the Glauber series and optical model from Feynman diagrams is generalized to nonzero scattering angles and any one-particle nuclear density. (5 figures) (auth)

60278 SIMPLIFIED MICROSCOPIC MODEL OF THE CORIOLIS ANTI-PAIRING TRANSITION. Vallieres, M. (Univ. of Pennsylvania, Philadelphia); Klein, A.; Dreizler, R. M. Phys. Lett.; 41B: No. 2, 125-9(18 Sep 1972).

The pairing-plus-quadrupole—quadrupole interaction is studied for a single-j level by a sum rule method ("current algebra") in the regime where the "nucleus" is deformed. The ground-state rotational band is shown to undergo the Coriolis anti-pairing transition. (auth)

60279 NUCLEAR MEDIUM CORRECTIONS IN ANALOG STATE EXCITATION BY DOUBLE CHARGE EXCHANGE OF PIONS. Barshay, S. (Univ. of Copenhagen); Vagradov, G. Phys. Lett.; 41B: No. 2, 130-4(18 Sep 1972).

Corrections from the nuclear medium relevant to the processes of excitation of nuclear analog states by double charge exchange of pions near the first resonance are calculated. The change in the effective pion wave number, the depletion of the flux available for the coherent excitation process, and the nonlocality in the nucleon density functions due to the nonzero momenta of the target nucleons serve to reduce the forward cross sections to less than 30% of the values estimated in the impulse approximation; the resulting values are in closer agreement with experiment. (auth)

60280 SHELL STRUCTURE FOR DEFORMED NUCLEAR SHAPES. Sheline, R. K.; Ragnarsson, I.; Nilsson, S. G. (Inst. of Tech., Lund, Sweden). Phys. Lett.; 41B: No. 2, 115-21(18 Sep 1972).

Eigenvalues for the harmonic oscillator without $l \cdot s$ or l^2 terms suggest a deformed shell structure for nuclei with axes ratio 2 : 1 and deformation $\epsilon = 0.6$ with corresponding nucleon "magic numbers" 2, 4, 10, 16, 28, 40, 60, 80, 110, and 140, the results being subject to small modifications due to spin—orbit and other correction terms. Experimental evidence of reasonably stable highly deformed structures corresponding to nucleon numbers 16, 20, 28, 40, and 60 (64) is presented. Attempts to calculate the corresponding potential energy surfaces by using the Strutinsky shell-correction method are described. (auth)

60281 RPA RENORMALISATION OF THE EFFECTIVE INTERACTION IN A HARTREE–FOCK BASIS. Ellis, P. J. (Nuclear Physics Lab., Oxford); Osnes, E. Phys. Lett.; 41B: No. 2, 97-101(18 Sep 1972).

The diagrams of the Tamm—Dancoff and random-phase approximations were summed in a Hartree—Fock basis to renormalize the effective interaction between two nucleons in the (1s0d) shell. The renormalization effects are found to modify rather little the results obtained with the bare matrix elements. In particular, the strong enhancement of the second-order core polarization diagram, which occurs in an oscillator basis, is found to be severely reduced in a Hartree—Fock basis. (auth)

60282 RELATIVITY AND M1 GAMMA TRANSITIONS IN NUCLEI. Savushkin, L. N. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 57-61(Nov 1971). (In Russian).

The M1-transitions in nuclei are treated in the framework of the single-particle relativistic approach. Interaction with the anomalous magnetic nucleon moment is considered relativistically in terms of the phenomenologically introduced Pauli interaction. The calculations of the M1-transition probabilities are performed using solutions of the Dirac equation for the rectangular potential, the "l-forbidden" transitions being of special interest since they become allowed in the relativistic theory. The question concerning the influence of the spin-orbit interaction upon the M1-type transitions in nuclei is investigated in connection with the "l-forbidden" transitions. (auth)

60283 SUM RULES FOR TWO-NUCLEON-TRANSFER REACTIONS. Bayman, B. F.; Clement, C. F. (Univ. of Minnesota, Minneapolis). Phys. Rev. Lett.; 29: No. 15, 1020-3(9 Oct 1972).

Exact relations between two-nucleon overlap functions are first obtained. With the two transferred nucleons restricted to a single major shell, sum rules are derived relating the difference between the sums of cross sections for two-nucleon stripping and pickup reactions on a given nucleus to its single-particle occupation probabilities. (auth)

60284 EFFECTIVE INTERACTION IN NUCLEI AND ITS PERTURBATION EXPANSION: AN ALGEBRAIC APPROACH. Schucan, T. H (Schweizerisches Institut fuer Nuklearforschung, Zurich); Weidenmueller, H. A. Ann. Phys. (N. Y.); 73: No. 1, 108-35(Sep 1972).

A finite-dimensional model for the Hilbert space of the A-nucleon problem is considered. In the frame of this model the energy-independent effective interaction, W, first introduced by Des Cloiseaux and Brandow is constructed explicitly. The connection between this explicit form and the implicit equation for W given by these authors is pointed out. The perturbation expansion of W in powers of the interaction is investigated by using the explicit form for W. (When used in the nuclear problem, this expansion leads to the folded diagrams.) It is shown that this expansion is likely to diverge in most cases of practical interest. Several methods are given which may yield a convergent expansion for W. The implications of the results for practical calculations are discussed. (2 figures) (auth)

60285 LOW-DENSITY EXPANSION OF THE NUCLEON–NUCLEUS OPTICAL-MODEL POTENTIAL. Huefner, J. (Univ., Freiburg i. B.); Mahaux, C. Ann. Phys. (N. Y.); 73: No. 2, 525-77(Oct 1972).

The optical-model potential for nucleon—nucleus scattering is studied within the framework of the Green's function approach to the many-body problem. The optical potential is identified with the self-energy, for which an expansion in terms of irreducible graphs exists. The diagrams of this expansion are grouped according to the number of independent hole lines, and the graphs within each class are summed. This procedure essentially amounts to an expansion in powers of the density, and is closely related to the Bethe—Brueckner expansion for the binding energy of nuclear matter. The same convergence parameter appears in both expansions. The one- and two-hole line contributions are studied in detail, and numerical estimates are provided and compared with experiment. At low energy, the expansion can be related to the calculation of the optical potential within the framework of nuclear reactions (e.g., using doorway states). At high energy one is led in a natural way to the expressions derived from multiple scattering theory. Thus, the hole-line expansion ties together the low- and high-energy domains of the optical potential. Hole line expansions for the momentum distribution and the total energy are derived from the expansion of the self-energy. The self-consistency requirement is discussed. The study is restricted to nuclear matter, but most results apply to finite nuclei as well. (11 figures) (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

60286 PLASMA PHYSICS. Samain, Andre (CEN, Fontenay-aux-Roses, France). pp 456-77 of Physics. Paris; Centre d'Etude et de Promotion de la Lecture (1971). (In French).

The definition of a plasma is recalled. The oscillation phenomena arising are discussed together with the problem of confinement and controlled thermonuclear fusion. (auth)

Confinement and Heating

60287 (UCRL-74087) CONFINEMENT STUDIES IN 2XII. Coensgen, F. H.; Cummins, W. F.; Molvik, A. W.; Nexsen, W. E.; Simonen, T. C. (California Univ., Livermore. Lawrence Livermore Lab.). 18 Aug 1972. 13p. (CONF-720804-8). Dep. NTIS.

From fifth European conference on controlled fusion and plasma physics; Grenoble, France (21 Aug 1972).

The containment of deuterium plasmas in a magnetic mirror well was investigated for mean plasma ion energies in the range from 1 to 10 keV. Evidence indicates that detectable plasma turbulence in this experiment arises primarily from instabilities driven by the presence of two or more maxima in the ion velocity function. Plasmas with no detectable turbulence were formed with mean energies in the range from 1.2 to 2.7 keV. The ion velocity functions of all quiescent plasmas have a single maximum. For these plasmas, neither the magnitude nor the density dependence of the loss rate was noticeably different for runs that were theoretically stable for the Dory—Guest—Harris mode and those that were unstable. In both cases $n\tau$ at high densities was below that calculated for collisional losses by a factor of two to three and decreased as the density fell. Although losses induced by other instabilities (e.g., drift-cyclotron, loss-cone mode) cannot be ruled out, the high-density data from quiescent decays appear to be in agreement with the Baldwin—Callen theory of "collective scattering". (auth)

60288 TRANSPORT OF rf ENERGY TO THE LOWER HYBRID RESONANCE IN AN INHOMOGENEOUS PLASMA. Briggs, R. J.; Parker, R. R. (Massachusetts Inst. of Tech., Cambridge). Contract AT(11-1)-3070. Phys. Rev. Lett.; 29: No. 13, 852-5(25 Sep 1972).

Localized coupling structures, such as open-ended waveguides located close to the plasma boundary, radiate a spectrum of electrostatic waves that are accessible to the lower hybrid layer in an inhomogeneous plasma. The energy flow is confined within narrow channels, similar to the resonance cone effect discussed by Fisher and Gould (Phys. Fluids, 14: 857(1971)). Radical changes in the energy-flow picture result if the constant-density contours are aligned at a small angle $[\sim(m_e/m_i)^{1/2}]$ to the magnetic field. (auth)

60289 OBSERVATION OF RADIO-FREQUENCY CONFINEMENT OF A PLASMA. Shelby, Charles F.; Hatch, Albert J. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 29: No. 13, 834-7(25 Sep 1972).

The breakdown field in a microwave cavity excited in the electric quadrupole mode exhibits a plateau at pressures below the electron mean-free-path limit of diffusion-controlled breakdown. The luminosity of a steady-state plasma in this domain exhibits a maximum at the central nodal point in the cavity field. These results are interpreted as evidence of rf confinement of a low-density plasma. (auth)

60290 PLASMA HEATING AND DENSIFICATION IN AXISYMMETRIC TOROIDAL PLASMA CONFINEMENT DEVICES. Hartman, Charles W. (to United States Atomic Energy Commission). U. S. Patent 3,677,890. 18 Jul 1972. Filed 23 Apr 1971.

A two-stage process and apparatus are described for generating and confining a hot, dense plasma for achieving controlled thermonuclear fusion in an axisymmetric toroidal confinement device. An electron plasma is trapped in a closed minimum-$|B|$ magnetic-mirror confining-field region of the device and raised to relativistic temperatures by electron-cyclotron resonance microwave heating. A cold dense pulse of neutral gaseous thermonuclear fuel is injected into the confining-field region for interaction with the hot electrons therein in a collisional heat-transfer mode productive of ion heating to multi keV temperature with a very high plasma density of the order of 10^{13} to $10^{14}/cm^3$. (auth)

60291 TRAPPING OF ELECTRONS IN MAGNETIC MIRRORS DUE TO ENHANCED FLUCTUATIONS. Roque, C. R.; Gregory, B. C. (Univ. of Quebec, Varennes). Phys. Fluids; 15: No. 11, 2046-53(Nov 1972).

A Fokker—Planck equation for an electron beam interacting with a turbulent plasma is derived. The Fokker—Planck coefficients are estimated using quasilinear theory. The equation is then applied to the problem of calculating the fraction of beam electrons trapped in a magnetic mirror device. The conditions under which the trapping compensates for the losses due to classical scattering into the loss cone are considered. (auth)

60292 ANALYSIS OF HOT-ELECTRON CONFINEMENT BY ELECTRON CYCLOTRON PLUGGING. Ikegami, H.; Aihara, S.; Hosokawa, M. (Nagoya Univ., Japan). Phys. Fluids; 15: No. 11, 2054-7(Nov 1972).

Plugging and confinement of hot-electron plasma by microwaves making use of the electron cyclotron resonance is studied. Experimentally, the plugging is observed to make a plasma decay time several times longer than that without the plugging microwave power, and the mechanism is analyzed theoretically. (auth)

60293 ION HEATING BY OBLIQUE SHOCK WAVES IN A HIGH-β PLASMA. Mizui, Jun—ichi; Nakai, Sadao; Kasuya, Koichi; Yamanaka, Chiyoe (Osaka Univ.). Phys. Fluids; 15: No. 11, 1941-7(Nov 1972).

Oblique shock waves in a high-β plasma ($\beta \sim 2$) had a monotonic structure with fluctuations either behind or ahead of the shock when the Mach number of the fast mode wave satisfied $M > 1$ (Alfvén Mach number $M_A = 2$ to 4). The characteristic length of the fluctuations was equal to the wavelength of the magnetoacoustic wave, and the shock width was found to be of order $2\pi c/\omega_{pi}$, where ω_{pi} is the ion plasma frequency in the upstream plasma. For $M > 1$, the post shock ion temperature consisted of two components. The appearance of the high-temperature ion component occurred when the fluctuations were observed. As the ion-heating mechanism, it is proposed that Landau damping of the wave energy selectively heats the resonant particles. (auth)

60294 PURIFICATION OF HYDROGEN PLASMOIDS BY THE MAGNETIC FIELD IN AN INJECTOR-DIVERTER. Atamanov, N. S.; Zalkind, V. M.; Zykov, V. G.; Il'enko, B. P.; Lats'ko, E. M. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 699-701(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 886-8(Apr 1972).

The mass composition of a plasma contained by the magnetic field of the injector—diverter device of the stellarator after external injection from a coaxial source was investigated with the use of a Thomson mass spectrograph. It is shown that the number of impurity ions in the plasma contained in the trap can be reduced substantially by reducing the pulse of the magnetic field opposed to the confinement magnetic field and choosing an appropriate delay between the triggering of the plasma injector and the pulse feed. (auth)

60295 ION HEATING BY GEOMETRICAL LANDAU DAMPING. Brownell, J. H. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica; 61: No. 2, 289-98(15 Sep 1972).

It is shown that in the limit of cold-plasma theory, a nonuniform magnetoplasma exhibits a low-frequency continuous spectrum (between the ion cyclotron frequency and a frequency related to the lower hybrid frequency) which leads to power absorption by the plasma. Upon adding a finite temperature the continuous spectrum becomes discrete, and energy absorption is possible for a time of the order of $(\Delta\omega)^{-1}$, where $\Delta\omega$ is the modal separation. A collision time shorter than this leads to irreversible heating of the plasma. (auth)

60296 INVERSE COMPTON SCATTERING AS AN ENERGY-LOSS MECHANISM IN A CONTROLLED THERMONUCLEAR REACTOR. Robinson, Paul A. Jr.; Sauter, George D. (Univ. of California, Davis). Nucl. Sci. Eng.; 49: No. 2, 117-29(Oct 1972).

Inverse Compton scattering, wherein a photon gains energy as a result of a reaction with a moving electron, was studied as a potential energy loss mechanism in the operation of a controlled thermonuclear reactor (CTR). Assuming local thermodynamic equilibrium within a 500-cm-diameter plasma at 20 keV, the influence of inverse Compton scattering on steady-state photon energy leakage via two potential cooling effects was calculated for various plasma densities: the increased escape probability of the photons generated within the plasma itself, and the negative net energy deposition within the plasma of an incident external photon flux, such as might be generated by the CTR radiation shield through (n,γ) reactions and photon scattering. For currently anticipated CTR plasma densities (10^{15} ions/cm^3), the increase in steady-state photon leakage due to inverse Compton scattering is negligible. For plasma densities of 10^{19} ions/cm^3 or more, the increase is significant ($\geq 10\%$). (auth)

Diagnostics

60297 THEORY OF THE SPHERICAL PROBE IN A DENSE PLASMA. Yastrebov, A. A. (Central Aerological Observatory, Dolgoprudnyi, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 637-45(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 809-20(Apr 1972).

Probe measurements in a weakly ionized plasma are discussed for the case of frequent collisions between charged particles and the neutral gas, in which case the motion of the charged particles can be described by the equations for a continuum. A variety of processes affecting the shape of the probe characteristics can be analyzed on the basis of this model. Exact solutions derived for spherical probes hold for a wide range of probe potentials and for arbitrary values of the other parameters in the problem. (auth)

60298 ELECTRON DENSITY MEASUREMENT IN A PULSED-ABLATION-ACCELERATOR PLASMA. Gubarev, V. Ya.; Kozlov, N. P.; Leskov, L. V.; Mikhailov, I. A.; Protasov, Yu. S. (Moscow Higher Technical School). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 650-2(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 826-9(Apr 1972).

The laser measurement of plasma density near the insulator surface in a pulsed ablation accelerator is discussed. The experiments are carried with a pulsed ablation accelerator of coaxial geometry with anode diameter D = 50 mm, cathode diameter d = 10 mm, and accelerator length l = 67 mm. The electrodes are copper. Teflon is used as the working medium. The accelerator is driven by a capacitor bank with a total capacitance of 600 μ at voltages from 1000 to 2000 V. A vacuum of 10^{-5} torr is maintained in all the experiments. The discharge is periodic, the current having two half-periods of 25 μsec each. The maximum discharge current with U_0 = 2000 V on the capacitor bank is 136 kA. The electron density is measured by the Topler shadow method with photoelectric detection. Electron density and relative mass efflux diagrams are given. (M.O.W.)

60299 INFLUENCE OF PROBE TEMPERATURE AND SIZE ON MEASUREMENT OF THE ENERGY DISTRIBUTION FUNCTION OF ELECTRONS IN PLASMA OF POSITIVE COLUMNS. III. Herrmann, D.; Klagge, S. (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Beitr. Plasmaphys.; 12: No. 1, 45-52(1972). (In German).

The second derivative is automatically recorded for the characteristic lines of probes varying with respect to size, shape, and temperature. The probes are used for determination of electron energy distribution, electron concentration, and electron temperature at the zero point of the second derivative under consideration of the space potential. With probes of various sizes, the distribution functions are measured for electron concentrations in the positive column of both helium and neon low-pressure discharges. The experimental values with a probe surface converging toward zero agree with values calculated according to the current balance equation. The second derivative of thin glow probes, heated to a point where the space charge layer is barely prevented from being destroyed by the emitted electrons, has approximately the same form as the second derivatives of ideal probes. (tr-auth)

Kinetics (General)

60300 (LBL-344) MANY USES OF PLASMA PHYSICS. Kunkel, W. B. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1971. Contract W-7405-eng-48. 26p. (CONF-710970-1). Dep. NTIS.

From German Physical Society conference; Essen, Germany (27 Sep 1971).

The many uses of plasma physics are described in order to demonstrate the diversity of the field. An attempt is made to focus on the basic plasma features which the various specialties have in common. The best known and probably most challenging application of plasma physics is controlled fusion. The emphasis here is placed on less well publicized although very important examples. Some of these are: a) the direct conversion of thermal into electrical energy, as for instance in the thermionic plasma diode; b) new developments in advanced laser technology; c) the production of intense x-ray and neutron bursts; and d) the acceleration of charged particles in collective fields. Many more could be cited but these should suffice to illustrate the richness of plasma physics. (auth)

60301 OBSERVED DISCREPANCIES IN THE CENTRAL REGION OF THE Hβ PROFILE AT LOW ELECTRON DENSITIES. Burgess, D. D.; Mahon, R. (Imperial Coll. of Science and Tech., London). J. Phys., B (London); 5: No. 9, 1756-61(Sep 1972).

Profiles of the Hβ transition were obtained at low electron densities ($n_e = 10^{15}$ cm^{-3}) in both a pure hydrogen plasma and also in a 99.99% helium plasma containing 0.01% hydrogen. The theoretically predicted central dip is entirely absent at this density for the hydrogen plasma, and is very much smaller than theory in the helium plasma. (auth)

60302 DISTRIBUTION OF CHARGED PARTICLES AND POTENTIAL IN AN INHOMOGENEOUS POSITIVE COLUMN. Konenko, O. R.; Musin, A. K. (All-Union Electrotechnical Inst., Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 616-21(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 782-8(Apr 1972).

Effects associated with the flow of an electrical current in an inhomogeneous gaseous medium are considered. Examples of such media are flames and high-temperature mixtures containing suspended particles, which act as centers for the scattering and absorption of charged particles, and low-pressure gas discharges with intermediate electrodes from whose surfaces electrons and ions are scattered and on which they recombine. A scattering model is proposed for such a medium, using an analysis of the effect of internal surfaces on the distribution of charged particles and on the potential drop. (auth)

60303 CURRENT SHEET COLLAPSE IN A PLASMA FOCUS. Jalufka, Nelson W. (Langley Research Center, Hampton, Va.); Lee, Ja H. Phys. Fluids; 15: No. 11, 1954-8(Nov 1972).

Collapse of the current sheets in a plasma focus was recorded simultaneously through slits parallel and perpendicular to the symmetry axis in the streak mode. The dark period following the collapse is due to the plasma moving out of the field of view. Microdensitometric measurements of intensity variation also support this conclusion. A large anisotropy is also found in the x-ray pattern. Effects of different vacuum vessels were investigated. (auth)

60304 GAS HEATING EFFECTS IN THE CONSTRICTION OF A HIGH-PRESSURE GLOW DISCHARGE COLUMN. Rogoff, Gerald L. (Westinghouse Research Labs., Pittsburgh). Phys. Fluids; 15: No. 11, 1931-40(Nov 1972).

Numerical calculations are made to examine effects of rapid gas heating and subsequent gas density changes on the current-density distribution in a high-pressure positive column. Radial profiles of gas temperature, radial expansion velocity, density, and pressure and of electron current density are calculated as functions of time for a simplified model of a glow-discharge column. Initially, the glow is diffuse and the background gas is uniform. Considered specifically is a hydrogen discharge with an initial pressure of 500 torr, an initial current of 6.0 A, a constant axial electric field of 10 kV/cm, and a radius of ~0.75 mm. The gas dynamics are described by conservation equations for mass, momentum, and energy in a viscous, thermally conductive, compressible fluid and by the equation of state for a perfect gas. The dependence of the ionization rate on the electric field to gas density ratio makes the electron current density a sensitive function of the gas density. At 60 nsec the gas temperature near the axis is sufficiently high for the onset of rapid thermal dissociation in an axial core, and effects of gas transport are significant. The axial gas density is decreased ~10%; the axial current density is twice its initial value; and the column is partially constricted. Calculated results are consistent with properties of a similar discharge studied experimentally by Cavenor and Meyer, particularly at the time of the formation of a filamentary channel, observed experimentally after the first stage of the flow-to-arc transition. (26 references) (auth)

60305 SHOCKED LAYER IN A COAXIAL PLASMA GUN. Jurak, K.; Offenberger, A. A. (Univ. of Alberta, Edmonton). Phys. Fluids; 15: No. 11, 2069-71(Nov 1972).

A revised, steady-state, quasi-one-dimensional model of the shocked layer in a coaxial accelerator is numerically solved for helium for a range of shock speeds that covers up to double ionization. (auth)

60306 CONTINUUM MEASUREMENTS ON A HYDROGEN PLASMA. Engelhardt, W. (Univ. of Maryland, College Park). Phys. Fluids; 15: No. 11, 2074-5(Nov 1972).

By measurement of the continuous emission in the visible and uv from an ionizing hydrogen plasma, it is shown that the main contribution to the continuum is due to the molecular continuum emitted by a small amount of 2% of H_2 molecules. (auth)

60307 DISCHARGES GUIDED BY LASER-INDUCED RAREFACTION CHANNELS. Saum, K. A.; Koopman, David W. (Versar, Inc., Springfield, Va.). Phys. Fluids; 15: No. 11, 2077-9 (Nov 1972).

Preliminary experiments demonstrating the channeling and guidance of an electrical breakdown streamer via a laser-induced rarefaction channel are reported. The ability of this phenomenon to extend the range of a given spark is also demonstrated. (auth)

60308 PLASMA PHYSICS AND CONTROLLED NUCLEAR FUSION RESEARCH. Conference Proceedings (English Translations of the Russian Papers), Madison, Wisconsin, June 17–23, 1971. Nucl. Fusion; Suppl., 1-357(1972). (CONF-710607–(Suppl.)).

This supplement volume to Nuclear Fusion contains the English translations of the 43 Russian papers presented at the Fourth International Conference on Plasma Physics and Controlled Nuclear Fusion Research held by the IAEA at Madison, Wisconsin, June 17–23, 1971. Abstracts of these papers may be found in NSA Vol. 25, No. 16. (M.O.W.)

60309 EXPERIMENTAL STUDY OF ELECTRIC AND THERMAL PROPERTIES OF STABILIZED ARCS. Donskoi, A. V.; Klubnikin, V. S.; Parkhomenko, A. S. (Leningrad Polytechnical Inst.). Inzh.-Fiz. Zh.; 22: No. 6, 1089-95(Jun 1972). (In Russian).

Electric field intensity, useful power of a plasma jet, electron temperature, and atom–ion gases in argon arcs at atmospheric pressure were studied. Expressions are obtained for the maximum useful power of the plasma jet and optimum arc length. The difference in the dependence of the electric field intensity and useful power of plasma jet on the arc length is explained by the thermal nonequilibrium state of argon plasma. (auth)

60310 RELATIVISTIC ELECTRON GAS. Gurchumeliya, A. D. (Georgian Polytechnic Inst., Tbilisi, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 2, 17-21(1972). (In Russian).

A model of free electron gas formulated on the basis of Breit's equation was examined by generalizing it in the case of many interacting electrons. The formula obtained made it possible to evaluate relativistic corrections down to energy levels in the atom which had α^2Z^4 and α^2Z^3. Comparison with quantum-mechanical calculations with a series of atoms yielded qualitative agreement. The possible principle of quantitative divergence is discussed. An expression for local exchange potential with respect to a relativistic description of the atom is offered. (tr-auth)

60311 ANALYTICAL AND EXPERIMENTAL STUDIES OF THERMIONICALLY EMITTING ELECTRODES IN CONTACT WITH DENSE, SEEDED PLASMAS. Koester, John K.; Sajben, Miklos; Zukoski, Edward E. (California Inst. of Tech., Pasadena). pp 54-60 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

Interactions are considered between a moving, alkali-metal seeded, dense plasma and a metallic electrode whose surface properties are influenced by the absorption of seed particles. The plasma behavior is governed by a set of differential equations, which are coupled to the surface through the boundary conditions. These conditions are obtained by utilizing the particle desorption rate expressions of Levine and Gyftopoulos. The solution of the problem yields the state of the surface as well as the spatial distribution of plasma properties. In particular, electrode voltage drops are predicted, which indicate whether the electrode operates in a thermionic or arc mode. The method was applied to a potassium-seeded argon plasma in contact with a tungsten electrode in a stagnation flow geometry. The results show that the plasma–surface interaction may lead to large electrode currents at moderate voltage drops. These currents can be up to an order of magnitude greater than what the random electron current would be at the surface under conditions of perfect thermodynamic equilibrium at the surface temperature. Results of a comparable experiment show reasonably good agreement with the theory. (auth)

60312 STUDIES WITH A DISK GENERATOR DRIVEN BY MOLECULAR GASES. Klepeis, James E.; Louis, Jean F. (Avco Everett Research Lab., Everett, Mass.). pp 62-3 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

A study was made in order to determine the bulk properties of the plasma and its kinetics at high Hall coefficients in various molecular gases. Disk generator experiments in nitrogen indicated electron temperature elevation and the occurrence of an ionization instability. Results are presented for the addition of CO_2. (M.O.W.)

60313 INFLUENCE OF CONTROLLED TURBULENCE ON GASEOUS DISCHARGES. Demetriades, S. T.; Maxwell, C. D.; Argyropoulos, G. S.; Fonda-Bonardi, G. (STD Research Corp., Pasadena). pp 64-9 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

An electrical discharge across a plasma stream can be prevented from becoming filamentary by introducing gasdynamic turbulence of controlled properties into the stream. This effect was verified by a simple experiment in the pressure range 1 to 300 torr, and was interpreted theoretically. The experimental results showed that the introduction of turbulence enhances the conductance of the discharge significantly, and were in excellent agreement with the theoretical predictions. The developed dispersion criterion shows that, under proper conditions, turbulence can disperse filaments also at atmospheric and higher pressures, and even more effectively if the gas is seeded. This effect can be used to improve the performance of all devices—ranging from gasdynamic lasers to MHD power generators—in which the behavior of a gas is affected by an electrical discharge. (auth)

60314 INVESTIGATION OF THE BEHAVIOR OF THE DISCHARGE AND THE FLOW IN A HOMOPOLAR DEVICE. Noeske, H. O. (General Electric Co., Philadelphia). pp 71-4 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

The observed modes and the dynamic behavior of an electric arc in a homopolar device for constant arc current (100 A) and magnetic field (1,500 G) were found qualitatively dependent on the type of gas used (He, Ne, Ar, and Xe). The peculiar behavior of the arc for both electrode polarities can be explained as the result of a competition between geometrical flow effects and the Hall effect, with the latter becoming more pronounced with decreasing pressure. The well known tendency of the cathode spot to move into the retrograde direction at low pressures under the effect of a transverse magnetic field is only of secondary importance. Two distinct arc modes for low gas pressures can be defined depending on electrode polarity: When the center electrode is the cathode, the confined current carrying section of the plasma moves together with the gas at high azimuthal velocity into the amperian direction. When the center electrode is the anode, the discharge becomes stationary in regard to the laboratory and diffuse and pumps the plasma with high speed in the azimuthal direction. No steady retrograde motion of the arc column was observed. (auth)

60315 DESIGN AND OPERATIONAL CHARACTERISTICS OF THE LANGLEY 20-MEGAWATT PLASMA ACCELERATOR FACILITY. Weaver, W. R.; McFarland, D. R.; Carter, A. F.; Wood, G. P. (Langley Research Center, Hampton, Va.). pp 77-81 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

A linear, steady-flow, Faraday-type plasma accelerator facility for high-velocity aerodynamic testing and basic research in magnetohydrodynamics was designed, constructed, and made operational. Use was made of the experience and results obtained with previous smaller, lower velocity accelerators. General design philosophy centered around three criteria: (1) make $j \times B$ as large as practicable, (2) operate with approximately constant current density, (3) maintain the Hall potential gradient constant across and along the channel. The accelerator has a 6.35-cm-square and 50-cm-long channel and utilizes nitrogen seeded with 2% mole fraction cesium vapor. A tailored magnetic field is provided. The duration of a typical test is 3 sec, with longer test times possible. The initial problems with the arc heater and the improvements necessary to make it a suitable plasma source are described. The final accelerator electrode current distribution and the electrode-wall potential distributions are given. Pitot pressure measured at the accelerator exit was 4.5×10^4 N/m^2, which indicated a velocity of 80% of the design velocity of 12,000 m/sec corresponding to a velocity increase to $2\frac{1}{2}$ times the entrance velocity. This accelerator appears to be the largest and highest velocity nonpulsed linear plasma accelerator in operation. (auth)

60316 LOCALIZED MAGNETIC BRAKING OF A PLASMA. Cenedese, A.; Cunsolo, D.; Piva, R. (Univ., Rome). Aerotec.-Missili Spazio; 50: No. 6, 345-51(Dec 1971). (In Italian).

In a plasma tunnel, as in electric propulsion, it is desirable to reduce to a minimum the heat exchange between walls and fluid without fundamentally altering the current characteristics. This can be done with a localized magnetic field developed by means of a series of threads immersed in the wall and fed with an alternating current; there would then occur a braking effect only on the fluid flowing in the proximity of the wall. In the hypothesis of low magnetic Reynold's numbers the magnetic field is not affected by the presence of induced current and can be determined independently of the aerodynamic field. In the present study an integral method for the evaluation of the effect of such a field is proposed; the fluid is assumed to be nonviscous and incompressible and the electric conductivity constant. (tr-auth)

60317 EFFECT OF NONUNIFORMITY OF THE HF ELECTRIC FIELD IN A PLASMA WITH FLOW. Goswami, S. N. (Maulana Azad Coll., Calcutta); Mitra, D. P. Indian J. Pure Appl. Phys.; 10: No. 3, 181-4(Mar 1972).

An analysis was made of the possible contribution of nonuniformity of the applied hf field to the characteristics of a steady-state, diffusion-controlled plasma, with flow. The results indicate that the effects of increasing flow and increasing nonuniformity are opposed. (auth)

60318 INTERACTION BETWEEN A MODULATED RELATIVISTIC BEAM AND PLASMA. Berezin, A. K.; Fainberg, Ya. B.; Bolotin, L. I.; (and others) (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 63: No. 3, 861-73(Sep 1972). (In Russian).

Results of an experimental and theoretical investigation of collective interaction between a modulated relativistic electron beam and a plasma are presented. The dependences of the modulated relativistic electron beam energy spectra at the exit of the interaction region averaged over the pulse duration on plasma density are measured. The time variation of "instantaneous" energy spectra is also determined for a plasma density for which collective interaction between the beam and plasma is maximal. Moreover, the frequency spectrum and phase velocity of the excited oscillations and also the time variation of the uhf electric field amplitude are measured. Coherent energy losses of a modulated relativistic beam and excitation of collective oscillations in a plasma due to the Vavilov—Cherenkov effect are observed. It is shown that oscillations with a narrow frequency spectrum can be excited in long plasma guides (l ~ 2 m) by employing relativistic modulated beams. The electric fields thus induced are mainly concentrated inside the plasma waveguide. (auth)

Kinetics (Experimental)

60319 (IPP-III-5) NONTHERMAL ELECTRON DENSITY FLUCTUATION IN HYDROGEN ARC STABILIZED BY A MAGNETIC FIELD. Ludwig, D. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Jul 1972. 52p. (In German). Dep. NTIS (U. S. Sales Only).

Deviations from the linear theory of light scattering for thermal plasmas are studied in detail. In a laser scattering experiment at a magnetized arc plasma the spectral resolution was improved by means of a Fabry—Perot interferometer from typically 5 to 10 Å to 0.3 Å. The spectrum of the scattered light revealed a fine structure showing peaks several tenths of an angstrom in width. Such narrow peaks could be "smeared out" in most of the cases by a poorer spectral resolution. Varying the scattering angle in discrete steps from 90° ($\alpha < 1$) to 15° ($\alpha > 1$) in forward direction has established that the scattered spectrum does not depend on the orientation of k (propagation vector of the observed density fluctuations) in respect to the magnetic field. At the same time the wavelength dependence of the fluctuation spectrum was determined. The nonthermal part of the spectrum is presented as a function of frequencies and wavelength in a three-dimensional array. The appearance of such deviations from the thermal theory in completely different plasmas (e.g., θ-pinch plasmas and arc plasmas) indicates that the scattering theory in many cases obviously has to take into account a nonthermal fluctuation spectrum. Especially oscillatory motions of the particles that result in frequency modulation of the scattered light must be dealt with. (auth)

60320 ELECTRIC CONDUCTIVITY OF XENON COLLISIONAL PLASMAS. Guenther, K.; Radtke, R. (Zentralinstitut fuer Elektronenphysik, Berlin). Beitr. Plasmaphys.; 12: No. 1, 63-72 (1972). (In German).

A method for measuring the electric conductivity of cylindrical discharge plasmas in dependence of temperature and of pressure with appreciable accuracy was developed. Results are given for $T = 10000$ to 12000°K and $p = 10$ and 20 at. Comparisons with calculations of Schirmer and Friedrich for partially ionized gases result in the proposal to cut off the interaction distance between charged particles at $a_0 = 2D$ instead of $a_0 = D$, where D is the Debye shielding parameter. With respect to the results the applicability of the Boltzmann equation and the Debye—Hueckel theory in the case of cold dense plasmas is discussed. (auth)

60321 EXPERIMENTAL STUDY OF THE LUMINOUS FRONT PRODUCED BY A COAXIAL PLASMA ACCELERATOR. Wisler, David C.; Nakagawa, Y. (National Center for Atmospheric Research, Boulder, Colo.). Phys. Fluids; 15: No. 11, 1948-54(Nov 1972).

A plane luminous front is produced in hydrogen by channeling the hot gas of the dense plasma focus formed in front of a coaxial accelerator into a small tube. The reflection of this luminous front by a solid wall is examined by using pressure and electron-density probes and streak photographs. The radiation of the luminous front is examined in detail by means of time-resolved spectroscopic measurements of the line emissions of H_α, H_β, H_γ, and H_δ, and the continuum emission across the Balmer series limit. Then, the population number densities of various excited states as well as the number density and temperature of electrons are determined. It is shown that, although a shock front propagates ahead of the luminous front, the observed luminosity results from the expanding hot driver gas and not from the shock heated gas. It is further shown that a satisfactory overall agreement between the results of the spectroscopic measurements and the theoretical solutions of the statistically steady-state rate equations is obtained with a correction for the self-absorption of the H_α line emission. (33 references) (auth)

60322 MOMENTUM TRANSFER INTERACTION OF A LASER-PRODUCED PLASMA WITH A LOW-PRESSURE BACKGROUND. Koopman, David W. (Univ. of Maryland, College Park). Phys. Fluids; 15: No. 11, 1959-69(Nov 1972).

The expansion of a laser-produced metallic plasma into a photoionized hydrogen background was experimentally studied. Langmuir-probe and microwave diagnostics detected an interaction front that decelerates with a dependence on background density and time consistent with a momentum coupling between the laser plasma and the ionized fraction of the background. An ion precursor was also observed. Calculations of scattering cross sections indicate that multiple-encounter Coulomb scattering will dominate collisional momentum transfer. The leading edge of the laser plasma contains multiply charged ions of charge state $z \geq 5$, and collisional effects appear adequate to explain the principal features of the momentum coupling. The ion precursor may have a collisionless origin. (41 references) (auth)

60323 PRODUCTION AND DESTRUCTION OF He (2^3S) METASTABLE ATOMS IN A HIGH PRESSURE HELIUM AFTERGLOW. Cheret, Michel; Lambert, Francis (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B; 275: No. 2, 77-80(10 Jul 1972). (In French).

The creation of metastable He (2^3S) atoms by recombination of electrons with molecular He_2^+ ions was observed in the afterglow of a helium discharge. (France)

Kinetics (Theoretical)

Refer also to abstract 60485.

60324 (AEC-tr-7349) INJECTION OF A RELATIVISTIC ELECTRON BEAM INTO A PLASMA. Rukhadze, A. A.; Rukhlin, V. G. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). Translation of report NP-18942. 16p. Dep. NTIS.

Reaction of a plasma when a relativistic electron beam of low density is injected into it is investigated. It is shown that for the condition $r_0 > c/\omega_p$, where r_0 is the radius of the beam and ω_p is the plasma frequency, all plasma perturbations are localized in the region of the electron beam itself and that currents induced in the plasma tend to compensate for the magnetic field, thus making its injection into the plasma easier. If the beam injection time $\tau > \tau_0 = 1/\nu(r_0\omega_p/c)^2$, where ν is the collision frequency of plasma electrons, the magnetic field compensation occurs at distances of $z < z_0 - u\tau_0$ from the leading front of the beam, where u is the directed velocity of the electron. In the case of a high-current electron beam, when the magnetic energy of the beam itself is greater than the kinetic energy of the electrons, facilitated injection is therefore possible only in a dense plasma under the conditions $\omega_p > c\, r_0$ and $\tau < \tau_0$. (auth)

60325 METHOD OF CALCULATION OF THE EMISSION COEFFICIENT OF A CYLINDRICAL PLASMA STARTING WITH THE EXPERIMENTAL INTENSITY PROFILE. Fabry, M.; Cussenot, J. R.; Richard, M. (Univ., Nancy). Opt. Commun.; 5: No. 4, 252-5(Jul 1972). (In French).

A numerical method for deducing the radial distribution of the plasma emission is described. It is applicable to an optically thin plasma with cylindrical symmetry. This method is well suited for experimental data known with their error bars. (auth)

60326 SOLUTION OF BOLTZMANN EQUATION FOR A FULLY IONIZED PLASMA BY SPHERICAL HARMONIC EXPANSIONS. Lupu, Gh. Bull. Math.; 13: No. 3, 349-67(1969). (In French).

The problem considered by Carpentier and Metzger is resumed, this time using nonnormalized, instead of normalized, harmonic expansions; the method has the advantage of yielding simpler, radical-free recurrence formulas. Boltzmann equation results are changed. Then, spherical harmonic expansions of the terms, including time derivatives and space gradient, are performed, as well as of those including the electric and the magnetic fields. The spherical-harmonic expansion of the Boltzmann equation is given. (Rom. Sci. Abstr.)

60327 QUASI-UNIDIMENSIONAL SOLUTIONS FOR EQUATIONS OF A HIGH-CURRENT ELECTRON BEAM. Danilov, V. N. Zh. Prikl. Mekh. Tekh. Fiz.; No. 4, 47-56(1972). (In Russian).

An adiabatic approximation is constructed on the basis of unidimensional solutions for equations of an axially symmetric double-flow beam. The effect of a weakly nonhomogeneous magnetic field can then be described for a stationary quasi-neutral beam. Tubular and laminated configurations of the beam confined near the axis are examined for currents of a magnitude that are critical and that substantially exceed the critical. (tr-auth)

60328 BOUNDARY OF THE QUASI-STATIC REGION OF ELECTRON BROADENING OF HYDROGEN LINES IN A PLASMA. Kogan, V. I.; Lisitsa, V. S. Opt. Spectrosc. (USSR) (Engl. Transl.); 32: No. 2, 216-17(Feb 1972).

Translated from Opt. Spektrosk.; 32: No. 2, 415-17(Feb 1972).

The theory of Stark broadening of hydrogen lines in plasma is based on two alternative approximations: the quasi-static and the impact approximation. The former is used to calculate broadening by ions and the latter, electrons. These are valid in regions of large and small frequency shifts, respectively. The characteristic frequency separating these two regions is $\Omega = v_0^2/\alpha$, (v_0 is the most probable velocity of the perturbing particles and α is the Stark constant of the component of the line). It is necessary to describe quantitatively the intermediate region for electron broadening where the transition from impact to quasi-static broadening takes place. Previous analyses have failed to determine the correct results. The transition domain between the two regions is investigated here from the point of view of the adiabatic approach. The approach permits the use of the same formulas for all lines of the spectrum. Formulas are derived for analyzing the boundary of the quasi-static region of electron broadening of hydrogen lines in a plasma. (J.C.W.)

60329 DISSOCIATIVE RECOMBINATION IN A GAS DISCHARGE. Babalyants, V. F.; Vurzel, F. B.; Gubanov, A. M.; Polak, L. S. Opt. Spectrosc. (USSR) (Engl. Transl.); 32: No. 2, 131-2(Feb 1972).

Translated from Opt. Spektrosk.; 32: No. 2, 249-51(Feb 1972).

The mechanism of electron–ion dissociative recombination of N_2^+ in a gas discharge is investigated. (auth)

60330 TURBULENCE CREATED IN THE INTERACTION BETWEEN A MONOENERGETIC BEAM AND PLASMA. Matsiborko, N. G.; Onishchenko, I. N.; Fainberg, Ya. B.; Shapiro, V. D.; Shevchenko, V. I. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 63: No. 3, 874-85(Sep 1972). (In Russian).

A nonlinear theory of hydrodynamic instability of a beam in a plasma is developed. The transition from excitation of a monochromatic wave to a "multimode" regime is studied with the aid of an electronic computer; "phase" mixing in a beam under such conditions is investigated. It is demonstrated that oscillation spectra excited during beam instability can be regulated by preliminary modulation of the beam. (auth)

Production

60331 (UCRL–74040) INTERACTION OF INTENSE PHOTON BEAMS WITH PLASMAS. II. Kidder, Ray E. (California Univ., Livermore. Lawrence Livermore Lab.). 18 Jul 1972. 32p. (CONF-720929–1). Dep. NTIS.

From Japan–U. S. seminar on laser interaction with matter; Kyoto, Japan (25 Sep 1972).

The elementary properties of light waves in a plasma are briefly reviewed, with particular attention to the Maxwell stresses. Two examples of optical stress effects are treated: steady-state self-focusing of light beams (transverse stress) and the density jump resulting from light pressure (longitudinal stress). The use of focused laser light to achieve super-high plasma density by rapid isentropic compression of a pellet of solid deuterium–tritium is discussed, an exact analytic expression for the required pressure-time profile being given for the case of spherical isentropic homogeneous compression. The application of laser-heated DT pellets to the production of electric power is considered, emphasizing the importance of extremely high pellet compression. The requirements that must be met by the laser and laser-heated pellets are described in the context of a practical fusion power plant. (auth)

60332 (UCRL-Trans–10645) GAS-DYNAMIC STRUCTURE OF A PLASMOID FORMED THROUGH EVAPORATION OF METALS BY STRONG OPTICAL IRRADIATION. Batanov, V. A.; Bunkin, F. V.; Prokhorov, A. M.; Fedorov, V. B. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from Preprint No. 50. 18p. Dep. NTIS.

The gas dynamics of vapors produced in the evaporation of metals with laser pulses of millisecond duration are investigated theoretically and experimentally. Heating of the vapors in the vicinity of the target by laser radiation was found experimentally. The initial conditions of motion of the vapors were studied. The flux j_1 of the gaseous phase is calculated from measured gas-dynamic quantities. The dependence of j_1 on the incident radiation intensity shows that a limiting temperature corresponding to the transition between a liquid metal and liquid dielectric is reached on the target surface. (auth)

60333 CHARACTERISTICS OF HOT-ELECTRON PLASMAS GENERATED BY A HIGH-CURRENT ELECTRON BEAM. Saito, Ryuta; Konagai, Chikara; Nakagawa, Takeshi; Akimune, Hideo; Suita, Tokuo. Technol. Rep. Osaka Univ.; 22: 43-9(Feb 1972).

Observations on an electron beam–plasma interaction are described. In the experiment, electrons with energy up to 2 keV are injected from one end of the magnetic mirror field. The state of the plasma is divided into three distinct modes with respect to beam current. In the third mode, it is observed that a large number of electrons with energy up to about 30 keV exist in the trap at a certain value of the beam current. The experimental results support Karkhov's explanation that these electrons may be produced by a resonant interaction between the bunched electron beam, associated with the electrostatic wave at the outlet of an electron gun, and the electromagnetic wave in the trap. (auth)

60334 LASER COMPRESSION OF MATTER TO SUPER-HIGH DENSITIES: THERMONUCLEAR (CTR) APPLICATIONS. Nuckolls, J.; Wood, L.; Thiessen, A.; Zimmerman, G. (Univ. of California, Livermore). Nature (London); 239: No. 5368, 139-42(15 Sep 1972).

Hydrogen may be compressed to more than 10,000 times liquid density by an implosion system energized by a high energy laser. This scheme makes possible efficient thermonuclear burn of small pellets of heavy hydrogen isotopes, and makes feasible fusion power reactors using practical lasers. (auth)

60335 FLUCTUATION CHARACTERISTICS OF A DENSE PLASMA OF HIGH CURRENT DISCHARGES PRODUCED BY ELECTRIC EXPLOSION OF METALLIC WIRES IN VACUUM. Nikolaev, F. A.; Novitskii, Yu. V.; Rozanov, V. B.; Sviridenko, Yu. P. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 3, 844-53(Sep 1972). (In Russian).

The fluctuation characteristics of a high-current discharge plasma produced by electric explosion of lithium wires in vacuum are investigated (discharge geometry is a straight z-pinch, W = 22.5 kJ, $\tau \approx 120\ \mu$sec, $I_{max} = 220$ kA, initial wire diameter d_0 is 0.17 mm, 0.34 mm, or 1.0 mm). Correlation treatment of signals from magnetic sensing elements yielded the mean size, velocity of the inhomogeneities and energy spectrum of the fluctuations. The magnetohydrodynamics equations are analyzed; this leads to relations for plasma pulsations which are in good agreement with the experimental data. It is concluded that plasma fluctuations of the discharge are determined by superheat instabilities peculiar to an optically transparent plasma. (auth)

Stability

Refer also to abstract 60352.

60336 EFFECT OF ION VISCOSITY ON THE STABILITY OF A FINITE-PRESSURE PLASMA. Tsypin, V. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 573-80(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 727-37(Apr 1972).

The effects of longitudinal ion viscosity (order ω/ν_i) and transverse ion viscosity and transverse ion thermal conductivity (order $k^2\rho_i^2\nu_i/\omega$) on the stability of a finite pressure plasma are investigated with respect to perturbations which are uniform along the static magnetic field. It is shown that a plasma with a uniform temperature is stable when $\beta > 1.2$; when $\beta < 1.2$ the growth rate of the instability is an order of magnitude smaller than the value predicted by qualitative estimates. A plasma with a nonuniform temperature is unstable for arbitrary β and for arbitrary magnitude and sign of the ratio $\varkappa_n/\varkappa_p$. (auth)

60337 STABILITY OF A PLASMA WITH AN AXIAL CURRENT SURROUNDED BY A COLD GAS WITH A PRESSURE GRADIENT. Elfimov, A. G. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 592-5(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 752-6(Apr 1972).

The stability of a plasma carrying an axial current in a longitudinal magnetic field surrounded by a cold nonconducting gas with a pressure gradient is considered. The pressure gradient is produced by rotation of the gas envelope. Rotation of the gas envelope stabilizes the plasma with respect to long-wave perturbations. A sufficient condition for stability for arbitrary m is $4\pi\rho_e w^2 \geq H_j^2$ (where w is the rotational velocity of the gas envelope ρ_e is the density of the envelope, and H_j is the magnetic field due to the axial current). Stabilization of the plasma by the combined effect of the longitudinal magnetic field H_z and rotation of the gas envelope is discussed. (auth)

60338 HYDRODYNAMIC CURRENT-DRIVEN INSTABILITY IN AN ELECTRODELESS INDUCTION DISCHARGE. Adamov, I. Yu.; Berezhnyi, V. L.; Dushin, L. A.; Kononenko, V. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 596-9(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 757-61(Apr 1972).

A hydrodynamic instability in an electrodeless induction discharge is investigated. The instability is caused by the current flow perpendicular to the magnetic field. The spectral characteristics of the oscillations excited in the plasma are obtained from the measurements of the scattering of electromagnetic waves by the plasma. The oscillation frequency $\Omega \sim qU \sim (\omega_{He}\omega_{Hi})^{1/2}$ and the fluctuation part of the density $n_e \sim n_0(m_e/m_i)^{1/2}$ predicted by the theory agree with the experimentally measured values. The energy distribution of the hydrodynamic oscillations is measured in the wave-number range 3 to 15 cm^{-1}. (auth)

60339 STABILITY OF THE TEARING MODE IN ASTRON. Fowler, T. K. (Univ. of California, Livermore). Phys. Fluids; 15: No. 11, 2075-7(Nov 1972).

It is shown by means of an energy principle that a neutralized astron E layer confined axially by its own magnetic forces is stable with respect to axial oscillations (the tearing mode). (auth)

60340 SIMULATION OF THE BEAM–PLASMA INSTABILITY IN A FINITE-LENGTH SYSTEM. Lin, A. T.; Rowe, J. E. (Univ. of Michigan, Ann Arbor). Phys. Fluids; 15: No. 11, 2034-40(Nov 1972).

The electron and ion beam–plasma instabilities in a one-dimensional finite-length system are studied by computer simulation methods using the discrete charge-sheet model. The results obtained using a one-component model indicate that the region of highly concentrated oscillation energy (due to a beam–plasma instability) near the beam entrance plane shrinks with time to a limiting value and then expands to form a stationary electric-field distribution. The frequency spectrum analysis of the electric field shows that only the first few harmonics of electron plasma oscillations have been excited and only these harmonics have amplitudes significantly above the noise level in the nonlinear region. In the experiment on the ion-beam interaction with a plasma, the plasma electrons and ions achieve greater heating in comparison with the heating resulting from the interaction between an electron beam and a plasma, because the heavier ion mass yields a larger energy source, a low rate of decrease of the mean ion-beam speed, and reduced thermal spreading of the beam particles. The excited electron plasma oscillations are found to dissipate into ion-density fluctuations whenever the amplitude exceeds some threshold value. (auth)

60341 COUNTERSTREAMING ION INSTABILITY FOR ARBITRARY ANGLES. Landau, Ronald W. (Naval Research Lab., Washington, D. C.). Phys. Fluids; 15: No. 11, 1991-2000 (Nov 1972).

The fully electromagnetic dispersion relation for two equidense counterstreaming ion beams flowing almost perpendicular to a magnetic field is derived. The beams flow through a warm stationary electron background treated using the Vlasov equation. The wavelengths must therefore be much smaller than the ion Larmor radius, but are assumed to be much greater than the electron Larmor radius. There is then an instability that occurs when $[\beta/(1 + 2\beta)] \leqq (m_-/m_+)(\bar{v}^2/V_0^2)$ ($\bar{v}$ and V_0 are the electron and ion velocities). It is found that in the region of fastest growth and for small β the instability growth drops sharply when the angular deviation of the wave vector from the direction perpendicular to the B field is greater than $(m_-/8m_+)^{1/2}$ for charged ions of mass m_+ or ~½° for protons. The transition to the zero field electrostatic case is also obtained by going to the $\beta \gg 1$ limit. (auth)

60342 PARAMETRIC INSTABILITY OF THE MODE m = 1 FOR THE DYNAMIC STABILIZATION OF A PLASMA FILAMENT. Beloozerov, V. N.; Zhukov, V. V.; Nikulin, M. G. Zh. Prikl. Mekh. Tekh. Fiz.; No. 4, 42-6(1972). (In Russian).

Parametric excitation of long-wave magnetohydrodynamic oscillations of the type m = 1 was examined for a cylindrical plasma conductor with an alternating high-frequency longitudinal current. The plasma cylinder was located in a constant longitudinal magnetic field and surrounded by a conducting sheath. The problem was solved for the model of a flexible filament assuming an ideally conducting plasma and sheath. Hill's method was used in investigating the stability of equations with periodic coefficients describing the oscillations of the filament. Computer computations yielded increments of oscillation instability in four first resonance zones at various values of system parameters. (tr-auth)

60343 ROLE OF LINEAR DAMPING FOR EXPLOSIVE INSTABILITIES. Jungwirth, K. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 22: No. 9, 756-62(1972).

It is shown that conservation laws of energy and momentum contain often sufficient information on various weakly nonlinear interactions. The changes in the temporal development of an explosive instability or its stabilization due to the linear damping of the interacting waves are discussed in more detail. (auth)

60344 ELECTROTHERMAL INSTABILITY IN PLASMAS WITH CURRENT FLOW PARALLEL TO THE MAGNETIC FIELD. Solbes, A.; Nakamura, T.; Kerrebrock, J. L. (Massachusetts Inst. of Tech., Cambridge). pp 209-15 of Engineering Aspects of Magnetohydrodynamics. /Elliott, D. G. (ed.). University, Miss.; Univ. of Mississippi (1970).

From 11th symposium on the engineering aspects of magnetohydrodynamics; Pasadena, CA. (24 Mar 1970). See CONF-700346.

The effect of a current flow, parallel to the magnetic field, on the stability, and on the effective conductivity and Hall parameter in the unstable state, of a nonequilibrium plasma, are studied theoretically and experimentally. Data obtained in argon–cesium and helium–cesium plasmas show excellent agreement between experiment and the theoretical prediction that the critical Hall parameter should increase as $(1 + \gamma^2)^{1/2}$ where γ is the ratio of currents parallel and perpendicular to the magnetic field. Measured variations, with average Hall parameter, of effective conductivity, and effective Hall parameter, also show good agreement with a quasi-linear theory including the effect of the parallel current. (auth)

Thermonuclear Processes

Refer also to abstracts 59322 and 60082.

60345 (UCRL–74057) SOME PROBLEMS ASSOCIATED WITH TRITIUM IN FUSION REACTORS. Hickman, Robert G. (California Univ., Livermore. Lawrence Livermore Lab.). 1 Aug 1972. 5p. (CONF-721111–2). Dep. NTIS.

From International meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX. (20 Nov 1972).

A number of problems associated with the use of tritium in fusion reactors are yet to be addressed. Some are peculiar to mirror machines and attempts at direct conversion of plasma energy to electricity, while others are of general concern. Several of these are considered from the point of view of one who has worked with tritium for several years. Specific areas mentioned include liquid phase mass transfer of tritium in liquid lithium, isotopic separation, preliminary calculations on permeation barriers, isotopic swamping, and some thoughts on maintenance. (auth)

60346 EFFECT OF A TRANSVERSE MAGNETIC FIELD IN TUMAN-2. Kaganskii, M. G.; Ovsyannikov, V. A.; Tyul'panov, S. S. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 600-5(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 762-8(Apr 1972).

A description is given of the toroidal Tuman-2 device, which is intended for the adiabatic compression of plasma by a rapid increase in the longitudinal magnetic field. Measurements are made of the transverse magnetic field component due to imperfections in the apparatus. The effect of the transverse field on the initial discharge conditions and the equilibrium is studied. It is shown for small displacements that the dependence of the current in the plasma on the transverse field is due to changes in the cross section of the plasma. (auth)

60347 MAGNETIC COMPRESSION CONTROLLED THERMONUCLEAR REACTOR. Coensgen, Frederic H.; Nexsen William E. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,677,889. 18 Jul 1972. Filed 8 Jul 1970.

Thermonuclear reactor utilizing a magnetic coil structure including a pair of intermeshed C-shaped electromagnetic coils (Yin—Yang configuration) is described in order to produce a magnetic confinement zone. Plasma is produced in a pulsed plasma source and is directed by magnetic fields into the region of said containment zone. A trapping field is produced by means of a second pair of C-shaped electromagnetic coils encompassing the first set to trap plasma in the said region. The first set of coils is then energized to contain and compress the trapped plasma thereby densifying and heating the plasma to a high temperature. (auth)

Wave Phenomena

60348 (ORNL-TM-3970) LANDAU DAMPING FOR ELECTROSTATICALLY CONFINED ELECTRONS. McCune, J. E. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 27p. Dep. NTIS.

A method for treating the Landau damping of electrons confined in almost parabolic potential wells is described. Crucial to the theory is the allowance for an energy dependence of the bounce frequency of the confined electrons. An approximate procedure for analyzing the one-dimensional periodic motion of particles in almost parabolic potentials is outlined, yielding a convenient method of relating a specific energy dependence of the bounce frequency to specific types of potentials. A computationally practical method for including electron Landau damping in the study of microinstabilities in mirror-confined plasmas is indicated. (auth)

60349 NONLINEAR WAVES IN A MULTICOMPONENT PLASMA WITH WEAK DISSIPATION. Pataraya, A. D. (Inst. of Physics, Tbilisi, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 568-72(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 721-6(Apr 1972).

Nonstationary weakly nonlinear modulated and unmodulated waves propagating along an externally applied magnetic field in a multicomponent plasma are investigated, taking account of weak dissipation. The unmodulated waves are investigated in a multicomponent plasma consisting of cold ions and hot electrons. The existence condition for these waves is obtained. The modulated waves are investigated in a cold plasma. An equation describing these waves is derived and the wave stability is investigated. (auth)

60350 LOW-FREQUENCY OSCILLATIONS IN A BOUNDED LOW-DENSITY PLASMA. Alanakyan, Yu. R.; Aivazyan, Yu. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 581-3(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 738-42(Apr 1972).

Low-frequency ionization—recombination oscillations in the density of a weakly ionized bounded low-pressure plasma are investigated. The frequency and damping of these oscillations are calculated. The damping of ion-acoustic waves due to ionization processes and recombination at the walls is also investigated. (auth)

60351 PROPAGATION OF SURFACE WAVES ALONG A PLANE BOUNDARY BETWEEN TWO MAGNETOACTIVE PLASMAS. Kaufman, R. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 587-91(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 746-51(Apr 1972).

A qualitative investigation is made of the dispersion equation for surface waves that propagate perpendicularly to a magnetic field along a plane boundary separating two regions of anisotropic plasma with different plasma frequencies (the magnetic field is parallel to the boundary). The regions in which surface waves can exist are determined as functions of ω and ω_H, where ω is the frequency of the wave and ω_H is the frequency of the electrons Various limiting cases are considered. (auth)

60352 ROLE OF TRAPPED PARTICLES IN PLASMA WAVES AND INSTABILITIES. Rosen, B. (Stevens Inst. of Tech., Hoboken, N. J.); Schmidt, G.; Kruer, W. L. Phys. Fluids; 15: No. 11, 2001-6(Nov 1972).

The role of trapped particles in large-amplitude electrostatic waves is studied in computer-simulation experiments. Both in waves generated by a beam—plasma instability and in waves excited externally, trapped particles are artificially untrapped or redistributed in phase space. It is found that removal of trapped particles eliminates amplitude oscillations and side-band growth while the redistribution of these particles in the trapping region leads to significant changes in damping rates, saturation levels, and sideband growth. (auth)

60353 RESONANCE, PARTICLE TRAPPING, AND LANDAU DAMPING IN FINITE-AMPLITUDE OBLIQUELY PROPAGATING WAVES. Palmadesso, P. J. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Fluids; 15: No. 11, 2006-13(Nov 1972).

The equations of motion for a particle in resonance with a small finite amplitude wave (ω,k) are solved approximately, using secularity-free perturbation theory. The wave propagates at an arbitrary angle to a uniform background magnetic field B_0, in an infinite collisionless plasma. The wavefields include a longitudinal electrostatic component and elliptically polarized transverse electric and magnetic components. The trajectories of trapped and resonant untrapped particles are described, for each of the possible waveparticle resonances defined by the condition $k_z V_z - \omega \approx NqB_0/m$, where N is an integer. These trajectories are used to construct an estimate of the nonlinear time-dependent Landau damping rate of the wave. (auth)

60354 HIGH-FREQUENCY MODULATION OF ION-ACOUSTIC WAVES. Albright, N. W. (Univ. of California, Los Angeles). Phys. Fluids; 15: No. 11, 2013-19(Nov 1972).

A large-amplitude, high-frequency electromagnetic oscillation is impressed on a nonrelativistic, collisionless plasma from an external source. The frequency is chosen to be far from the plasma frequency (in fact, lower). The resulting electron velocity distribution function strongly modifies the propagation of ion-acoustic waves parallel to the oscillating electric field. The complex frequency is calculated numerically. (auth)

60355 NONLINEAR COUPLING OF ION-ACOUSTIC WAVES IN A COLLISIONLESS PLASMA. Mix, L. P. Jr.; Litzenberger, L. N.; Bekefi, G. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids; 15: No. 11, 2020-6(Nov 1972).

Measurements of the spatial evolution of nonlinearly generated ion-acoustic waves propagating along a collisionless, magnetically confined plasma column produced by electron cyclotron breakdown of argon gas are presented. An ion-acoustic wave is generated by applying a sinusoidal voltage (amplitude 0.25 to 10 V rms, frequency 0.25 to 3.0 MHz) to a grid immersed in the plasma. A second, movable grid and an interferometric technique are used in the determination of the damping and phase velocity of this wave and of the second harmonic wave. The observed spatial growth and subsequent decay of the harmonic wave are compared with predictions of mode-coupling theory. Good agreement is obtained provided that the ratio $e\Phi_F/\kappa T_e \lesssim 0.01$, where Φ_F is the potential of the fundamental wave and T_e is the electron temperature. For larger values of Φ_F, discrepancies between measured and computed matrix elements occur. (auth)

60356 SIMULATION OF ION-ACOUSTIC WAVE AND PSEUDOWAVE GENERATION IN A PLASMA. Estabrook, Kent; Alexeff, Igor (Oak Ridge National Lab., Tenn.). Phys. Fluids; 15: No. 11, 2026-33(Nov 1972).

The unexpected effects of a grid in attempts to launch ion-acoustic waves are discussed. A time varying potential on a grid was found to inherently produce ion bursts (pseudowaves) at all voltages and frequencies used. The voltages ϕ ranged from low ($e\phi = \kappa T_i$), to medium ($e\phi = kT_e$), to high ($e\phi \gg \kappa T_e$) in cases where the electron-to-ion temperature ratio was large ($T_e/T_i = 30$). The frequencies f used ranged from below to above the ion plasma frequency $f_{pi}(0.25f_{pi} \leq f \leq 2f_{pi})$. Ion-acoustic waves, however, could be clearly observed only for low excitation voltages and for frequencies at and below the ion plasma frequency. In the computer simulation, the grid is treated as a one-dimensional source of potential, and particle absorption and scattering by the grid wires is neglected. A one-dimensional ion distribution function $F(x, v, t)$ is found by numerically integrating the nonlinear ion Vlasov—Poisson equations by a finite difference method for phase space. Electrons are treated as a massless neutralizing fluid, and the electron density is computed by balancing the electric field against the thermal electron pressure in a self-consistent fashion $[n_e = n_0 \exp(e\phi)(\kappa T_e)^{-1}]$. (auth)

60357 IONIZING-GAS-BREAKDOWN WAVES IN STRONG ELECTRIC FIELDS. Klingbeil, R.; Tidman, D. A.; Fernsler, R. F. (Univ. of Maryland, College Park). Phys. Fluids; 15: No. 11, 1969-73(Nov 1972).

An analysis of ionizing potential waves is made that includes photoionization. It is found that photoionization plays an important role in the avalanche propagation. Velocities, electron densities, and temperatures are given as a function of electric field for both negative and positive breakdown waves in nitrogen. (auth)

60358 RESONANCES OF AN ANTENNA ASSOCIATED WITH THE EXCITATION OF ION BERNSTEIN MODES. Schmitt, J. P. M. (Ecole Polytechnique, Paris). Phys. Fluids; 15: No. 11, 2057-60 (Nov 1972).

The impedance with respect to the plasma of a wire parallel to the magnetic field is studied theoretically and experimentally. The theoretical boundary-value problem is solved through linearization and completed by numerical calculation. The wire impedance as a function of frequency is shown to exhibit peaks above the ion cyclotron harmonics corresponding to the passbands of ionic Bernstein waves. Experiments are performed in a single-ended Q machine and led to results in good agreement with theory. (auth)

60359 STRUCTURE OF THE THIRD-ORDER PLASMA WAVE ECHO. Goforth, R.; Gentle, K. W. (Univ. of Texas, Austin). Phys. Fluids; 15: No. 11, 1974-80(Nov 1972).

Electron plasma wave echo experiments were performed and are compared with the theoretical description from the Vlasov equation. The previous theory is extended to third order for comparison with the experiment. Measurements of the wavelengths and envelope of the echo are in good agreement with the extended theory. (auth)

60360 PROPERTIES OF SPATIAL BALLISTIC PLASMA-WAVE ECHOES. Ripin, B. H.; Pechacek, R. E. (Univ. of Maryland, College Park). Phys. Fluids; 15: No. 11, 1980-90 (Nov 1972).

Spatial electron plasma wave echo experiments are described in which the relation between the echo wavelength and frequency is given by $\omega_3/k = v_c$, where v_c is approximately equal to the velocity at which the electron distribution function has maximum slope. It is concluded that the echo response is dominated by free-streaming electrons. Other evidence is also presented which supports this conclusion. The experimental results corroborate many of the properties of free-streaming disturbances derived from an expansion of the Vlasov—Poisson system. Numerical integrations of the derived expressions for the second-order ballistic echo electric field compare favorably with experiment. The mechanism by which electrons are perturbed by the externally applied fields (e.g., in velocity or density) is found to influence the detailed structure of the echo response. (20 references) (auth)

60361 SAWTOOTH, SOLITARY, AND TURBULENT WAVES IN A WEAKLY IONIZED PLASMA. Sato, Tetsuya (National Oceanic and Atmospheric Administration, Boulder, Colo.); Ogawa, Tadahiko; Matsuda, Yoshiyuki Phys. Fluids; 15: No. 11, 1926-30(Nov 1972).

Nonlinear evolution due to many-mode couplings is studied numerically for an inhomogeneous, magnetized, weakly ionized plasma. It is found that a sawtooth (shock-like) solution is achieved for the low range of an external parameter (weak nonlinearity), and that the solution becomes localized and soliton-like for the larger parameter range (strong nonlinearity). The parameter value differentiating the solution from a shock-like to a soliton-like shape is coincident with a critical value predicted by a theory beyond which the system becomes explosively unstable. It is further shown that the turbulent spectrum obeys a power law of K^{-3} which is predicted by the theory. (auth)

60362 COUPLED FIELDS IN WARM STRATIFIED PLASMAS. Anderson, W. C.; Burman, R. (Univ. of Western Australia, Nedlands). Czech. J. Phys.; 22: No. 9, 763-75(1972).

Small-amplitude coupled electromagnetic and electron acoustic waves, as described by Maxwell's equation and single-fluid hydrodynamics, are studied in a horizontally stratified, continuously varying, warm electron plasma. First-order coupled wave equations are used to investigate the fields in a coupling region, and the results are compared with those obtained from second-order coupled wave equations. All field components are found to be finite in the coupling region. (auth)

60363 DEPENDENCE OF HELICON WAVE RADIAL STRUCTURE ON ELECTRON INERTIA. Boswell, R. W. (Flinders Univ. of South Australia, Bedford Park). Aust. J. Phys.; 25: No. 4, 403-7(Aug 1972).

An analytic expression for the dispersion of traveling helicon waves in a uniform nonresistive plasma is used to show the effect of electron inertia on the radial structure of the wave in a cylindrical plasma bounded by perfectly conducting walls. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 58850 and 59781.

60364 (JUL–856-TP) MASS ABSORPTION COEFFICIENT FOR X RAYS. A TABULAR COMPARISON OF THE VALVES ACCORDING TO THE FORMULA OF KELLY AND HEINRICH. Preuss, E. (Kernforschungsanlage, Juelich (West Germany). nstitut fuer Technische Physik). May 1972. 64p. (In German). Dep. NTIS (U. S. Sales Only).

The mass absorption coefficients of chemical elements of the periodic system were calculated from lithium up to plutonium in the field of wavelengths from 0.6 to 15 Å, according to the formulas of KELLY and HEINRICH. For this purpose, a computer program (PLI) was made which prints the values in tabular form. Thus, it is feasible to compare the formulas of the abovementioned authors. This comparison is of interest for evaluating the results of the quantitative electron microprobe analysis, in particular when correcting programs by SPRINGER and COLBY are used. (auth)

60365 (RD/B/M–2376) SOME ASPECTS OF A SYMPOSIUM ON NEUTRON DOSIMETRY IN BIOLOGY AND MEDICINE. The Symposium was Organized by Euratom and held at Neuherberg, Munich, 15–19 May 1972. Harvey, J. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jul 1972. 20p. Dep. NTIS (U. S. Sales Only).

The symposium produced an up-to-date picture of the work going on in many important areas of neutron biophysics. Conventional and novel techniques of neutron dose measurement were discussed in depth. Some new personnel dosimetry systems show promise, but none are yet suitable for widespread application within the C.E.G.B. It seems unlikely that improvements in the precision of theoretical and experimental depth-dose assessment will have a significant effect on permitted levels. Several papers relate to the calibration of neutron sensitive instruments. The work on microdosimetry has wide implications in many fundamental areas of radiological protection such as risk estimation and the value of "dose spreading." A paper on the importance of intermediate energy neutrons within a nuclear power program is given as an appendix. (auth)

60366 THREE-PARAMETER FORMULA FOR THE ELECTRONIC STOPPING CROSS SECTION AT NONRELATIVISTIC VELOCITIES. Brice, David K. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev. A; 6: No. 5, 1791-1805(Nov 1972).

The Firsov formalism for calculating the electronic stopping cross section has been modified by (i) giving a precise quantum-mechanical definition of the electron flux across the Firsov plane in terms of the bound-state wave functions and (ii) by including the relative motion of the Firsov plane in the flux calculation. This formalism is then extended in a semiphenomenological manner to the velocity region where the relative velocity of the colliding atoms is of the same order of magnitude as the orbital velocities of their electrons. When hydrogenic 1s wave functions are used, three adjustable parameters result from this treatment, one from the modification of the Firsov formalism and two from the extension to higher velocities. It is found that adjustment of these parameters to give a best fit to experimental data yields an expression that accurately gives the electronic stopping cross section S_e for any collision partners at all nonrelativistic velocities. The three parameters are considered as adjustable for the purposes of this paper, but it is shown here that the low-energy parameter Z is calculable from first principles. In addition, one of the high-energy parameters a is shown to be a linear function of the target atomic "radius." (auth)

60367 RANGE–ENERGY RELATIONS FOR N, Na, AND Ar IONS (0.3 to 2.0 MeV) IN Ar, N_2, O_2, AND AIR. Langley, Robert A. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev. A; 6: No. 5, 1863-9(Nov 1972).

Ionization extrapolated ranges have been measured for N ions (0.3 to 2.0 MeV) in N_2 and air, for Na ions (0.3 to 2.0 MeV) in air, and for Ar ions (0.3 to 1.0 MeV) in Ar, N_2, O_2, and air. A magnetically analyzed beam of ions was brought through a differential-pumping system into a gas stopping cell. A single-grid ionization chamber, movable along the beam axis, was used to obtain the data necessary to plot a Bragg curve. The observed range–energy relations are compared with previous data where possible. The accuracy of the measurements is ±3%. (auth)

60368 ORIGIN OF ORIENTED MAXIMA IN THE BREMSSTRAHLUNG SPECTRA OF NONRELATIVISTIC ELECTRONS IN A SINGLE CRYSTAL. Kalashnikov, N. P.; Koptelov, E. A.; Ryazonov, M. I. (Moscow Engineering Physics Inst.). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 4, 1033-4(Oct 1972).

Translated from Fiz. Tverd. Tela; 14: No. 4, 1211-13(Apr 1972).

A quantum-mechanical treatment is given of the bremsstrahlung from nonrelativistic electrons in a single crystal. As electrons move parallel to a crystallographic plane, there are states with a discrete spectrum of transverse motion. The emission of a quantum accompanied by a transition into a state in the discrete transverse motion spectrum leads to formation of oriented maxima in the bremsstrahlung spectrum. An explicit expression is obtained for the differential bremsstrahlung cross section, in agreement with existing experimental data. (auth)

60369 "POVERA E NUDA VAI, DOSIMETRIA." Rindi, A.; Thomas, R. H. (Univ. of California, Berkeley). Health Phys.; 23: No. 5, 715-27(Nov 1972).

The concepts used in radiation protection are critically reviewed. It is concluded that primary attention should be given to the specification of radiation fields in terms of particle flux density and energy spectra, from which all other parameters needed in health physics may be derived. (64 references) (auth)

60370 ENERGY LOSS OF FISSION FRAGMENTS FROM ^{252}Cf IN ARGON. Forte, M. (CCR–EURATOM, Ispra, Italy); Bertin, A.; Bruno, M.; Vannini, G.; Vitale, A. Lett. Nuovo Cim.; 4: No. 13, 587-92(29 Jul 1972).

The apparatus used allowed a direct measurement of the ionization loss and of the mass of a given fragment by determining, for each fission event, both the energy lost and the residual energy of the fragments crossing a given gaseous path. The apparatus used solid-state and gas ionization detectors. The results of the measurements are discussed. (M.O.W.)

60371 INVERSE BREMSSTRAHLUNG ABSORPTION IN LARGE RADIATION FIELDS DURING BINARY COLLISIONS: CLASSICAL THEORY. Pert, G. J. (Univ. of Hull, Eng.). J. Phys., A (London); 5: No. 4, 506-15(Apr 1972).

A simple method of calculating the inverse bremsstrahlung absorption coefficient in binary collisions is presented. The approach allows calculations to be made of the absorption at any field strength provided the field is classical and the electron is nonrelativistic and its thermal distribution function is isotropic. Calculations are made for electron/atom collisions interacting by a power low central force. The results are extended to discuss absorption in plasmas. The effects of electron–electron and inelastic collisions are also considered. (auth)

60372 EVALUATION OF MASS ENERGY-ABSORPTION COEFFICIENTS OF BONE AND MUSCLE. Atwater, H. F. (Los Alamos Scientific Lab., N. Mex.). Health Phys.; 23: No. 5, 739-40(Nov 1972).

Mass energy-absorption coefficients of bone and muscle for 10 keV to 10 MeV photons were calculated using computational methods based on experimental and theoretical data and are tabulated. These values differ by no more than 4% from the 1964 NBS values but should be more accurate and consistent since the energy dependence of the K-shell photoelectric contribution to energy absorption is treated explicitly in the calculations and also improved incoherent scattering factors are used. (UK)

60373 IRRADIATION EQUIVALENCE. Katz, R.; Sharma, S. C.; Homayoonfar, M. (Univ. of Nebraska, Lincoln). Health Phys.; 23: No. 5, 740-2(Nov 1972).

It is impossible to write an expression describing the effect of irradiation as a product of two factors, one of which contains only parameters describing the detecting system, while the other contains parameters describing only the radiation field. From this perspective it is difficult to understand the use of a "quality factor," applicable to all biological substances and given as a function of the "effective LET," for the conversion of rads to rems. It is impossible to define, and a single instrument cannot measure, a universal "radiation quality." However, a useful, simplified description of the interaction of a radiation field with a particular detector in a particular ambient environment is possible by specifying the "equivalent track-segment bombardment." For cells, this is the bombardment yielding equal survival for equal dose, under the specified conditions. The existence of an equivalent track segment bombardment for a mixed radiation field for a particular cellular system in a particular environment is demonstrated. (UK)

60374 SCATTER-AIR RATIOS. Cunningham, J. R. (Ontario Cancer Inst., Toronto). Phys. Med. Biol.; 17: No. 1, 42-51(Jan 1972).

Scatter-air ratios are defined as empirical quantities derived from tissue-air ratios for use in calculating the dose from scattered radiation at a point in an irradiated phantom. It is pointed out that like tissue-air ratios, for each radiation quality, they depend only on depth and beam cross-section, but are independent of the distance from the source. Their use for calculations within uniform and non-uniform radiation beams is outlined and the extension to account for tissue-heterogeneities is discussed. (auth)

60375 COMPARISONS OF RADIATION DOSIMETRY BETWEEN HOUSTON (USA), EDINBURGH (UK), AND UMEA (SWEDEN). Almond, P. R. (Anderson Hospital and Tumor Inst., Houston, Tex.); Law, J.; Svensson, H. Phys. Med. Biol.; 17: No. 1, 64-70(Jan 1972).

Comparative dose measurements between Houston, U.S.A., Edinburgh, U.K., and Umea, Sweden are reported, using ionization chambers, LiF powders and $FeSO_4$ solutions. Differences between the three centers only once exceeded 1% and were never statistically significant. (auth)

60376 INELASTIC ENERGY LOSSES IN SMALL-ANGLE SCATTERING OF ENERGETIC PARTICLES. Bierman, D. J. (FOM-Inst. voor Atoom- en Molecuulfysica, Amsterdam); Turkenburg, W. C.; Bhalla, C. P. Physica; 60: No. 2, 357-74(Aug 1972).

Measurements are presented of inelastic energy losses, Q, dissipated in scattering events between a range of elements as projectiles and neon and argon atoms as target particles. Scattering angles are in the range between 10′ and 140′. The velocity of all the projectiles is 4.38×10^7 cm/s. Oscillations in Q as a function of the atomic number of the primary ion are observed. The experimental values are compared with calculations based upon the semiclassical modified Firsov theory. The qualitative agreement between experiment and theory is satisfactory in case of argon as a target but relatively poor when neon is used as a target gas. (auth)

60377 POSITRON PASSAGE THROUGH AN ELECTRON GAS. Khalvashi, Kh. T. (Tbilisi State Univ., USSR). Phys. Lett.; 41A: No. 4, 290(9 Oct 1972).

The passage of a charged particle through an electron gas is analyzed. The electron gas is considered as a plasma that oscillates with the Debye frequency. At the same time the electron gas polarization by the electric field of a passing positron is taken into account. The positron energy loss per unit time is calculated. The thermalization time of high-velocity positrons is obtained. This time depends on the density of a metal, namely on the electron gas density according to the experimental data. (auth)

60378 STRAGGLING OF MODERATELY RELATIVISTIC ELECTRONS. Ehrman, J. B. (Univ. of Western Ontario, London). J. Phys., A (London); 5: No. 9, 1320-36(Sep 1972).

A simple analytical model for computing range-energy straggling of moderately relativistic electrons is set up. Both inelastic scattering and bremsstrahlung are considered as sources of straggling. The model gives overestimates for radiative straggling, but it is indicated how this overestimation may be removed. The simple (overestimating) model is used to compute range straggling for electrons up to kinetic energies of 4 MeV in uranium and up to 30 MeV in aluminium. The occurrence of the infinities in Eyges' radiative straggling treatment [Phys. Rev., 76: 264-9(1949) and 77: 81-5(1950)] are explained and removed. The results justify the neglect of straggling in electron transport when applied to photon production, as done by other workers. (auth)

60379 DOSE OUTSIDE USEFUL BEAM IN WATER AND REALISTIC PHANTOMS EXPOSED TO CHEST RADIOGRAPHIC PROCEDURES. Vacirca, S. J.; Thompson, D. L. (State Univ. of New York, Brooklyn). Health Phys.; 23: No. 4, 533-6(Oct 1972).

A realistic phantom consisting of tissue-equivalent material, skeleton, and air cavities was exposed to x rays in chest radiographic procedures and dose measurements were made outside the useful beam. A similar study was performed by another group using a water phantom. Data from these two independent studies were compared at corresponding points. The relative doses at various depths and distances from the edge of the useful beam were plotted together for the trunk and skull regions. In the trunk region the agreement between realistic and water phantom data was quite good for those points compared (up to 10 cm depth and 45 cm from the edge of the useful beam). In the skull region values for the realistic phantom were as much as 100% higher than those for the water phantom. This was accounted for by the anatomical asymmetry of the body. The results showed that water phantom data was comparable to realistic phantom data when applied to the region of the trunk. When applied to the skull region the dose estimates had to be modified by appropriate correction factors. (auth)

60380 INFLUENCE OF MOLECULAR BINDING ON THE STOPPING POWER OF ALPHA PARTICLES IN HYDROCARBONS. Williamson, J.; Watt, D. E. (Steetley Mfg. Ltd., Hartlepool, Eng.). Phys. Med. Biol.; 17: No. 4, 486-92(Jul 1972).

Stopping powers of ^{239}Pu alpha particles in hydrocarbon compounds in the gaseous and solid state were measured with the object of determining the relative effects due to the chemical structure and the physical state of the compound. The following compounds were studied: C_2H_6, C_4H_{10}, C_2H_4, C_3H_8, C_4H_8, C_2H_2, C_3H_4, C_4H_6, CH_4, C_6H_6, H, C, polyethylene, polypropylene. Differences observed were attributed entirely to charge exchange effects. Previously published results (Thompson, T. J., 1952, Ph.D. Thesis, Univ. California.), which claimed to demonstrate a small molecular binding contribution to the stopping power, are shown to be invalid on the basis of a full statistical analysis. (auth)

60381 ANALYTICAL FORMULA OF K-SHELL PHOTOEFFECT FOR INTERMEDIATE AND HIGH Z ATOMS. Hla, Yin Yin (Arts and Science Univ., Rangoon); Khaing, Chit; Su, May; Ghose, A. M. Nucl. Instrum. Methods; 104: No. 1, 73-5(1972).

A theoretical calculation of photoeffect is not available in analytic form, and extraction of photoelectric cross sections for a specific element and photon energy requires a formidable amount of computation time. To remove this difficulty an analytical formula for K-shell photoeffect was developed semiempirically which is valid for intermediate and heavy elements ($Z \geq 50$) and for photon energies above 150 keV. The formula agrees almost exactly with the high-energy limit calculated exactly by Pratt, while at intermediate energies it agrees with screened potential calculation of Schmickley and Pratt, as well as with the experimental results available in this region. (auth)

60382 ENERGY LOSS OF THE HIGH ENERGY ELECTRONS. Belousov, A. S.; Malinovskii, E. I.; Rusakov, S. V.; Shareiko, P. N. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 16: No. 2, 339-42(Aug 1972). (In Russian).

The electron energy-loss measurements within the 90- to 550-MeV region and at 31 GeV were made. The experimental dE/dx values are an attractive fit to the theoretical ones without using radiative corrections. These measurements were performed at the 250- and 660-MeV electron synchrotrons of the Lebedev Physical Institute and the electron beam of the 70-GeV IHEP proton synchrotron (Serpukhov). (auth)

60383 COMPUTATION OF TWO-DIMENSIONAL DOSE DISTRIBUTIONS IN ^{60}Co-TELETHERAPY WITH COPLANAR BEAMS. Allewaert, J. A. (Kliniek voor Radiothrapie en Kerngeneeskunde, Ghent). Phys. Med. Biol.; 17: No. 5, 613-23(Sep 1972).

A simple method is given for the computer calculation of two-dimensional dose distributions in ^{60}Co teletherapy with stationary and moving beams. Wedges of constant slope may be used and corrections for oblique incidence and for tissue inhomogeneities are included. The method is restricted to rectangular fields and coplanar beams. (auth)

60384 MEASURED X-RAY SPECTRA FROM 25 TO 110 kVp FOR A TYPICAL DIAGNOSTIC UNIT. Waggener, Robert G.; Levy, Louis B.; Rogers, Lee F.; Zanca, Peter (Univ. of Texas, San Antonio). Radiology; 105: No. 1, 169-75(Oct 1972).

Diagnostic x-ray spectra were measured with a NaI(Tl) spectrometer system. A digital computer was used to correct the observed spectrum and to find the true spectrum by solving a matrix equation. X-ray spectra for various diagnostic x-ray units were measured under different conditions of focal spot size, duration of exposure, tube current, and kVp. Half-value layer, effective photon energy, and mean energy were measured and compared for similar x-ray units. The principal variation in x-ray spectra was related to differences in kVp and tube filtration. Focal spot size and mAs variation did not significantly influence the measured x-ray spectra. (auth)

Radiation Source Calibration and Standardization

60385 CHANGE OF GAMMA-RAY EXPOSURE-RATE STANDARDS BY THE NATIONAL BUREAU OF STANDARDS. Loevinger, R. (National Bureau of Standards, Washington, D. C.). Phys. Med. Biol.; 17: No. 5, 665(Sep 1972).

A brief announcement by the U. S. National Bureau of Standards is made to the effect that after 1 May 1972, all calibrations of instruments for ^{60}Co and ^{137}Cs γ rays will be carried out with reference to exposure-rate standards that are 0.7% lower and 0.6% lower, respectively, than those used previously. (UK)

PHYSICS (SOLID-STATE)

Radiation Effects

Refer also to abstracts 58910, 60059, and 60479.

60386 (COO–3158-9) DIRECT OBSERVATION OF POINT DEFECTS IN IRRADIATED OR QUENCHED METALS BY QUANTITATIVE FIELD ION MICROSCOPY. Seidman, David N. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). 1 Aug 1972. 59p. (CONF-720934–1). Dep. NTIS.

From International conference on point defects and their aggregates in metals; Guildford, Sussex, UK. (18 Sep 1972).

Progress in applying the field ion microscope (FIM) technique to the study of point defects in irradiated or quenched metals is reviewed. The techniques involve essentially the atom-by-atom dissection of specimens by pulse field evaporation and the corresponding recording on film of the extensive number of FIM images produced at each stage of the process. Methods have been developed which allow the recording and the analysis of as many as $\sim 5 \times 10^5$ frames of 35mm cine film for a single investigation. The application of these techniques to the following problems was discussed: (1) the mobility of self-interstitial atoms (SIA's) in Substage I_E of irradiated tungsten and platinum, (2) the geometric configuration of SIA's, (3) the point defect structure of depleted zones in tungsten, and (4) the properties of monovacancies and divacancies in quenched platinum. 101 references. (auth)

60387 (FRNC-TH–261) RESISTIVITY AND ENERGY OF FORMATION OF FRENKEL PAIRS IN PURE AND ALLOYED Ni. Paillery, Annick (Grenoble Univ. (France)). 1972. 44p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Experimental techniques used are described: preparation of samples, low-temperature irradiation devices, and devices for postirradiation studies. Results obtained from coupled resistivity–liberated energy experiments with pure Ni, Ni–Si, Ni–Ag, and Ni–Be alloys are given. Several mechanisms are suggested to explain the effect of the different impurities. The following observations were made: all the impurities trap Ni interstitials and delay their annihilation in the vacancies; during the process of defect creation, the Be impurity is ejected into interstitial positions; the recombination energy of a Frenkel pair is considerably reduced by the proximity of a Si impurity. (France)

60388 RECOMBINATION AND CAPTURE PROBABILITIES IN POTASSIUM IODIDE–THALLIUM CRYSTALS. Martynovich, E. F.; Parfianovich, I. A.; Nemirovskii, Yu. B. (Irkutsk State Univ., USSR). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 4, 1061-2 (Oct 1972).

Translated from Fiz. Tverd. Tela; 14: No. 4, 1240-2(Apr 1972).

KI–0.1 mole% Tl crystals were x irradiated at 260°K and then stimulated by F-band light pulses. The resulting luminescence has a short-lived and a long-lived component. The effects of x-irradiation time and optical/thermal decolorization on the attenuation time τ of the long-lived component and the ratio γ of the long-lived to the short-lived component intensity were studied. When the x-ray dose increases, τ and γ increase, contradicting the predictions of the band model. Changes in Tl^{2+} center concentration and γ with decolorization agree qualitatively with theory, but the changes are too small. An explanation for the results is that, owing to the influence of the electric field of the activator holes on the electrons released from the F centers, the recombination and capture probabilities become functions of the distance between the activator holes and the F centers. (D.L.C.)

60389 DIFFUSION PROCESSES IN IRRADIATED MOLECULAR CRYSTALS. Mikhailov, A. I.; Bol'shakov, A. I.; Lebedev, Ya. S.; Gol'danskii, V. I. (Inst. of Chemical Physics, Moscow). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 4, 1000-6(Oct 1972).

Translated from Fiz. Tverd. Tela; 14: No. 4, 1172-9(Apr 1972).

A ESR study of the recombination of free radicals in irradiated molecular crystals shows that it is possible to study diffusion processes with low diffusion coefficients $D \sim 10^{-18}$ cm^2/sec from the kinetics of the annealing of point radiation defects. Results indicate that in a solid there takes place a whole series of diffusion processes, which apparently differ in the activation energy (E) of the limiting stage. An algorithm was developed for determining the principal kinetic parameters—the range of values of $E(E_1,E_2)$, the distribution functions of the particles f(E), and the preexponential factor (K_0). The influence of extended defects (dislocations, etc.) on the magnitude of the potential barriers for the translational movement of the particles in a solid is discussed. For the stepwise recombination of radicals in acrylonitrile, $E_1 = 8$ kcal/mole, $E_2 = 15.4$ kcal/mole, and $K_0 = 10^{-7}$ cm$^3 \cdot$ sec^{-1}. These data on the translational mobility were used to distinguish the kinetic and diffusion stages of post-polymerization in solid acrylonitrile. (auth)

60390 COLOR CENTERS IN $Y_3Al_5O_{12}$ CRYSTALS. Batygov, S. Kh.; Voron'ko, Yu. K.; Denker, B. I.; (and others) (Lebedev Physics Inst., Moscow). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 4, 839-41(Oct 1972).

Translated from Fiz. Tverd. Tela; 14: No. 4, 977-80(Apr 1972).

Investigations were made of the absorption spectra and thermal deexcitation curves of $Y_3Al_5O_{12}$ crystals activated with different rare earth elements and γ-irradiated at 300°K. Pr^{3+} and Tb^{3+} greatly increase the absorption of the irradiated crystals in the range 300 to 500 nm, associated with the formation of TR^{4+} ions as a result of the γ irradiation. Europium and ytterbium are reduced during irradiation to Eu^{2+} and Yb^{2+}; the remaining lanthanides do not form divalent ions that are stable at 300°K. The recombination processes that take place during heating in γ-irradiated $Y_3Al_5O_{12}$ crystals containing Ce, Pr, Tb, or Eu are accompanied by thermoluminescence with spectra characteristic of trivalent activators; the activators that do not form stable divalent ions (Dy, Sm) are not thermoluminescent and this suggests that the TR^{3+} ions are excited directly as a result of recombination of electrons and holes at these ions. (auth)

60391 HARDENING IN KCl CRYSTALS IRRADIATED AT LIQUID NITROGEN TEMPERATURE. Okada, Touichi; Ohji, Kenzo; Suita, Tokuo; Ozawa, Kunio. Technol. Rep. Osaka Univ.; 22: 33-42(Feb 1972).

Experimental studies of radiation hardening were made on pure and sodium-doped KCl crystals, both irradiated by γ irradiation at LNT. It was observed that H_A band (historically V_1 band) growth was enhanced by sodium-impurity doping. A simultaneous recovery study of radiation-induced flow stress and H_A band showed that a considerable part of radiation-induced hardening ($\Delta\tau$, flow stress increase) at LNT is due to H_A centers (stabilized H centers). However, other hardening agents that contribute to another part of $\Delta\tau$ are not clear, although they might be thought of as some type of interstitial halogen clusters. (auth)

60392 EFFECTS OF PLASTIC DEFORMATION ON F-AGGREGATE COLOR CENTERS IN ALKALI HALIDES. Sakai, Takao; Okada, Touichi; Suita, Tokuo; Ozawa, Kunio. Technol. Rep. Osaka Univ.; 22: 21-32(Feb 1972).

The effect of plastic deformation on F-aggregate color centers in gamma-irradiated NaCl was investigated. The plastic deformation results in the decrease in R_1 and R_2 bands accompanied with the growth of an optical absorption band at 690 nm. The enhanced band was assigned to be a transition of F_3^+ center. (auth)

60393 KINETICS OF THE DIFFUSION OF SELF-TRAPPED HOLES IN ALKALI HALIDE SCINTILLATORS. Dietrich, H. B.; Murray, R. B. (Univ. of Delaware, Newark). J. Lumin.; 5: No. 3, 155-70(Jul 1972).

Previous measurements of the reorientation kinetics of V_k centers (self-trapped holes) permit a determination of the diffusion coefficient at room temperature in NaI, KI, RbI, and KCl. Utilizing these diffusion coefficients, Waite's diffusion-limited reaction theory is used to calculate the time required for self-trapped holes to migrate to thallium centers in NaI(Tl), KI(Tl), RbI(Tl), and KCl(Tl). The lifetime of an electron trapped at a thallium site as a Tl^0 center is also estimated from thermoluminescence measurements. It is concluded that V_k centers diffuse and are captured at thallium sites in a time less than or comparable with the scintillation pulse decay time for the alkali iodides, and that the very long hole-diffusion time in KCl(Tl) is consistent with the absence of a scintillation effect in that crystal. (auth)

60394 RADIATION-INDUCED DEFECTS AND THEIR INFLUENCE ON THE CRITICAL CURRENT IN SUPERCONDUCTING NIOBIUM. Tsypkin, S. I. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 3, 811-12 (Sep 1972).

Translated from Fiz. Tverd. Tela; 14: No. 3, 942-4(Mar 1972).

The dimensions of the defect accumulations which affect the superconducting critical current J_c of Nb are determined by the energy distribution of the primary Nb atoms which experience direct hits with the bombarding ions. The minimum energy T_{min} of the primary atoms is estimated by comparison of 30-MeV ^{14}N ion results (Sov. Phys. Solid State 13: 2588(1972)) with the

15-MeV deuteron results of Coffey et al. (Phys. Rev., 155: 355 (1967)). The J_c increase is related to defect accumulations formed by primary atoms of energy $T > T_{min}$, where $0.7 \text{ MeV} < T_0 \leq T_{min} \leq 13.7 \text{ MeV}$. A small number of defect accumulations of sufficiently small size can increase J_c more than a much greater number of smaller defect accumulations. This is inconsistent with neutron irradiations at 4.2°K, however (Berndt et al., Zs. Ang. Phys. 24: 305(1968)). (D.L.C.)

60395 MECHANISM OF RADIATION-INDUCED COLORING OF KCl:Ag CRYSTALS. Mel'nikov, N. I.; Zhitnikov, R. A.; Baranov, P. G. (Physical-Technical Inst., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 3, 753-6(Sep 1972).

Translated from Fiz. Tverd. Tela; 14: No. 3, 884-8(Mar 1972).

Electron paramagnetic resonance and optical spectroscopy were used to study the mechanism of the formation of various silver centers which are produced during the radiation-induced coloring of KCl: Ag crystals. The investigations concerned themselves mainly with the processes leading to the formation of Ag_a^- ions, which replace the anions in the KCl lattice (B centers). A four-stage formation mechanism of the B centers is proposed: (1) formation of cation silver atoms Ag_k^0 through electron capture by Ag_k^+ ions; (2) migration of anion vacancies to Ag_k^0 atoms and formation of Ag_F^0 centers; (3) formation of anion Ag^- ions through electron capture by Ag_F^0 centers, with the Ag^- ions having a cation vacancy in the immediate vicinity; and (4) migration of the cation vacancy from the Ag^- center and formation of a B center. A model of ionized B centers is also considered. It is shown that neutral Ag_a^0 silver atoms are formed in the optical ionization of B centers and that the Ag_a^0 silver atoms are stabilized at anion lattice points. (auth)

60396 LOW-TEMPERATURE ELECTRON-IRRADIATION DAMAGE AND RECOVERY IN PYROLYTIC GRAPHITE. Iwata, Tadao; Nihira, Takeshi; Matsuo, Hideto (Japan Atomic Energy Research Inst., Tokai). J. Phys. Soc. Jap.; 33: No. 4, 1060-70 (Oct 1972).

The electrical resistivity changes by electron irradiation at 5°K and the isochronal annealing of resistivities in the temperature range 5 to 85°K (Stage I) in pyrolytic graphite are studied in order to get information on point defects. Both the a-axis and the c-axis resistivity changes by irradiation are explained by the ordinary transport theory with defect scattering. Small recoveries in Stage I are shown to be composed of four substages: I_A (5 to 15°K), I_B(15 to 45°K), I_C (45 to 65°K), and I_D(65 to 85°K). Effects of electron energy, radiation doping and graphitization temperature on these substages are also studied. Substages I_A and I_B may be caused by the correlated rearrangement of close Frenkel pairs, where interstitial atoms are loosely coupled with their own vacancies. The activation energy for I_A is roughly estimated to be 0.027 ± 0.004 eV. In I_C, long-range free migration of interstitial atoms seems to occur. (auth)

60397 X-RAY STUDY OF NEUTRON-IRRADIATED LiF CRYSTALS. Hayashida, Hideto; Kazumata, Yukio; Maeta, Hiroshi (Japan Atomic Energy Research Inst., Tokai). J. Phys. Soc. Jap.; 33: No. 4, 1100-7(Oct 1972).

The nature of defects produced in LiF crystals by neutron irradiation for a dose of $\sim 10^{18}$ nvt at different temperatures was studied by x-ray diffraction. Large lattice expansion and small change of the line width of the diffraction profile were observed in the crystal irradiated at about 0°C, while small change of the lattice parameter and large broadening of the line width were observed in the crystal irradiated at 80°K. It was concluded that (1) the defects produced by neutron irradiation at about 0°C were point-like and distributed homogeneously; (2) the majority of the defects produced by the irradiation at 80°K were of zone type and the amount of point-like defects was small; (3) both types of defects were produced at intermediate temperatures between the above two. (auth)

60398 MODIFIED NONCENTRAL-FORCE MODEL FOR RARE-EARTH H.C.P. METALS. Pratap, R.; Kushwaha, S. S. (Banaras Hindu Univ., India). Nuovo Cim.; 11B: No. 1, 138-44 (11 Sep 1972).

Lattice dynamics of holmium is discussed, visualizing the metal as a series of point ions immersed in a localized electron gas. The model includes three kinds of interactions: the ion—ion central force out to the third nearest neighbor, the ion—ion angular force effective on second and third neighbors, and the ion—electron interaction. De Launay is followed to obtain ion—ion central-force and ion—ion angular-force components. The contribution from the ion—electron interaction is sought on the lines of Bhatia. The phonon dispersion relations and $\theta - T$ curve are plotted and compared with the experimental results. (auth)

60399 CORRELATION OF VOID SIZE AND POSITRON ANNIHILATION CHARACTERISTICS IN NEUTRON-IRRADIATED MOLYBDENUM. Cotterill, R. M. J.; Mackenzie, I. K.; Smedskjaer, L.; Trumpy, G.; Traff, J. H. O. L. (Danish Atomic Energy Commission, Risoe). Nature (London); 239: No. 5367, 99-101 (8 Sep 1972).

Progress in studies of void formation in metals has been slow because of the long irradiation time required to make voids observable by electron microscopy, and because this technique is destructive it has not been possible to follow the evolution of voids in a single sample. A new nondestructive technique is described for the study of crystal defects which uses the positron as a probe to study properties of these imperfections, and results of an investigation of positron behavior in neutron-irradiated Mo containing voids of diameter 30 to 40Å are reported. Neutron irradiation was carried out in the Dounreay high-flux reactor. It was found that the voids were arranged in a macroscopic lattice whose direction vectors were parallel to those of the host lattice. The void specimens were also examined by 2-photon angular correlation, to obtain information on the momentum distribution of the annihilating electron—positron pairs. A pronounced effect of voids on the angular correlation curve was observed, and it was found that narrowing depended on void diameter or, at least, on void size distribution. The question of positronium formation is also discussed, and also the trapping of positrons in voids. It is suggested that the technique may hold promise as an "early warning" system for impending rupture in reactor fuel cladding and other critical reactor components, particularly in fast power reactors, due to swelling as a result of void formation. (UK)

60400 EFFECT OF VOIDS ON ANGULAR CORRELATION OF POSITRON ANNIHILATION PHOTONS IN MOLYBDENUM. Mogensen, O.; Petersen, K.; Cotterill, R. M. J.; Hudson, B. (Danish Atomic Energy Commission, Risoe). Nature (London); 239: No. 5367, 98-9(8 Sep 1972).

For sufficiently high defect concentrations all positrons become trapped in the defects before annihilation, thus changing the characteristics of the annihilation process. For example, trapping of positrons may result in increase of positron lifetime, a narrowing of the 2-γ angular correlation distribution, and a reduction in the Doppler broadening of the annihilation line. A study is reported on the effect of voids produced by fast neutron irradiation of Mo to about 3×10^{22} n/cm^2 (>1 MeV) in the Dounreay high-flux reactor at about 650°C. A 2-γ angular correlation curve for polycrystalline Mo containing voids and a curve for annealed polycrystalline Mo are shown. The measurements were made at room temperature, and an external source of ^{22}NaCl was employed. The effect of the voids was confirmed by measurements of the Doppler broadening of the annihilation line. Placing the samples in a 20-kG magnetic field produced no significant change in Doppler broadening measurements, indicating that probably no Pb is present in the voids. The presence of voids caused very pronounced narrowing of the angular correlation curve. Possible explanations for the effects observed are advanced. (UK)

60401 NUCLEATION OF VOIDS IN IRRADIATED STAINLESS STEEL. Laidler, J. J.; Mastel, B. (Hanford Engineering Development Lab., Richland, Wash.). Nature (London); 239: No. 5367, 97-8(8 Sep 1972).

Considerable attention has recently been given to the phenomenon of void formation or three-dimensional clusters of lattice vacancies in metals; the retention of vacancies in the form of such stable secondary defects results in a significant volume expansion of the void-containing material. With the use of austenitic steels as fuel cladding and for core structural components, core design is complicated by this swelling, and it is desirable to eliminate or minimize the effect. With the availability of high-voltage electron microscopes, the very early stages of void formation can be studied by direct observation of specimens while under irradiation in the microscope, and using this technique the nucleation and growth of voids in AISI Type 316 stainless steel were observed. The types of voids formed, together with their nucleation and subsequent behavior, are described. The observations should be of value in assessing the swelling resistance of materials for fast breeder reactor applications, and it should be possible to adjust material parameters to suppress void nucleation. (UK)

60402 THRESHOLD ENERGY FOR TELLURIUM DISPLACEMENT IN ZINC TELLURIDE. Bryant, F. J.; Baker, A. T. J. (Univ. of Hull, Eng.). J. Phys., C (London); 5: No. 16, 2283-8 (Sep 1972).

A study of the cathodoluminescence edge emission spectrum of zinc telluride at liquid helium temperatures after bombardment with monoenergetic electrons in the 100 to 500 keV energy range was made. Production of a sharp emission at 2.362 eV after electron radiation damage of p-type zinc telluride at 77°K allowed the determination of an energy threshold at 300 keV, which is assigned to the displacement of tellurium atoms. An electron of 300 keV is capable of transferring a maximum of 6.7 eV to a tellurium atom. (auth)

60403 BOUNDARY SCATTERING OF PHONONS IN SILICON CRYSTALS AT ROOM TEMPERATURE. Savvides, N.; Goldsmid, H. J. (Univ. of New South Wales, Kensington, Australia). Phys. Lett.; 41A: No. 3, 193-4(25 Sep 1972).

The thermal conductivity of single-crystal silicon was measured at room temperature and at 200°K before and after neutron irradiation. It was observed that, after irradiation, an appreciable boundary scattering effect occurs for crystals of 20 to 100 μm thickness. (auth)

60404 NUCLEAR MAGNETIC RESONANCE ABSORPTION OF POLYTETRAFLUOROETHYLENE γ-IRRADIATED AT HIGH TEMPERATURES. Tutiya, Mituaki (Tokyo Metropolitan Isotope Research Center). Jap. J. Appl. Phys.; 11: No. 10, 1542-6(Oct 1972).

The NMR spectra of PTFE irradiated at various temperatures with a dose of 1.1×10^7 R and irradiated at 340°C with various doses were measured over the temperature range from −50 to 50°C. In the case of PTFE irradiated with 1.1×10^7 R, the percent crystallinity estimated from NMR spectra increased with increasing irradiation temperature up to about 300°C, but decreased abruptly above 320°C, and increased again. In the case of PTFE irradiated at 340°C, the crystalline transition temperature was shifted to a lower temperature at 1.1×10^7 R and the NMR line shape changed into a single component at 1.1×10^8 R. The crystal imperfections due to irradiation at 340°C were caused by high viscosity during irradiation, occlusion of low molecular degradation products, low degree of chain fractures, and structure changes such as branches, crosslinkings, etc. (auth)

60405 LATTICE LOCATION OF Sb IMPLANTED IN GaAs SINGLE CRYSTALS. Gamo, Kenji (Osaka Univ.); Masuda, Kohzoh; Namba, Susumu; Ilic, Gradimir. Jap. J. Appl. Phys.; 11: No. 10, 1577-8(Oct 1972).

70-keV Sb ions were randomly implanted into (111) or (100) faces of GaAs crystals at room temperature or 550°C. 1-MeV He backscattering and channeling effect techniques were used to study the lattice location. The average projected range and standard deviation were determined to be 230 and 90 Å. The substitutional component of Sb is 80 to 90% for both irradiation temperatures, with no interstitial component. 40 to 80% of the Sb was lost by annealing at 900°C for 20 min. (D.L.C.)

60406 DISPERSION ENERGY OF VOID CLUSTERS IN IRRADIATED METALS. Lucas, A. A. (European Space Research Organisation, Noordwijk, Netherlands). Phys. Lett.; 41A: No. 4, 375-6(9 Oct 1972).

It is shown that a very long-range, dispersive-type interaction exists between voids in metals which may contribute to the void crystallization phenomenon. (auth)

60407 SOME APPLICATIONS OF AN ULTRAHIGH-VOLTAGE ELECTRON MICROSCOPE ON MATERIALS SCIENCE. Fujita, Hiroshi (Osaka Univ.); Tabata, Teizo; Yoshida, Kiyokazu; Sumida, Naoto; Katagiri, Shinjiro. Jap. J. Appl. Phys.; 11: No. 10, 1522-36(Oct 1972).

Fundamental problems for application of a 3-MV-class electron microscope were examined at 2 MV on various materials such as aluminum, copper, 18-8 type stainless steel, and gold as follows: (a) The maximum observable thickness of these specimens at 2 MV is generally 12 to 13 times larger than those at 0.1 MV. And thus, it is expected that processes of various phenomena in most materials can be continuously observed as same as in bulk specimens by the electron microscopy. (b) The anomalous transmission of electrons clearly occurs at the symmetry position of 111 reflections at 2 MV even in aluminum. (c) Total amount of secondary defects due to electron irradiation damage strongly depends not only on the order of reflections but also on deviation from the Bragg condition. When the anomalous transmission at the symmetry position occurs, the amount of defects shows the maximum value at the symmetry position of reflections. (d) Utility of capsules is examined on determination of the liquid structure and oxidizing processes of aluminum. (auth)

60408 EPR AND ENDOR SURVEY OF RADIATION EFFECTS IN NaF. Meyer III, Samuel Lewis. Lafayette, Ind.; Purdue Univ. (1972). 137p. University Microfilms Order No. 72-21,239.

Thesis.

The H center in NaF was discovered and analyzed by EPR. The anisotropic electronic g factor and the constants describing the anisotropic hyperfine interaction between the unpaired spin and the molecular fluorine nuclei are presented. Results show that the H center is equivalent to an interstitial fluorine atom or an F_2 molecule−ion located on an anion site with the molecular axis in the [111] direction. The $H_A(K)$ center in NaF : K was also discovered and analyzed by EPR. Constants describing the hyperfine interaction between the unpaired spin and the primary and secondary fluorine nuclei are presented. The components of the anisotropic electronic g factor are also presented. The EPR spectra of the H and $H_A(K)$ centers are analyzed by spin Hamiltonian diagonalization techniques. Results show that the $H_A(K)$ center is equivalent to an F_4^{3-} molecule-ion with the molecular axis in the [110] direction. The primary fluorines are equivalent to an interstitial fluorine atom in the form of an F_2^- molecule located on an anion site. Results of an EPR and ENDOR study of a radiation-induced impurity center in NaF : Fe are also presented. The EPR spectrum is analyzed in terms of a highly anisotropic electronic g tensor, and an attempt is made to derive these g values by a Hamiltonian diagonalization procedure. Results of the EPR study demonstrate that this center is most probably an iron impurity in the form of Fe^{3+} located in an interstitial position. The ENDOR hyperfine constants for the nearest sodium and fluorine nuclei are presented. (Diss. Abstr. Int., B)

60409 HELIUM SOLUBILITY, MOBILITY, AND IMPLANTATION EFFECTS IN POTASSIUM BROMIDE. Wayne, R. C.; Bauer, Walter (Sandia Labs., Livermore, Calif.). Phys. Rev., B; 6: No. 10, 3966-73(15 Nov 1972).

The solubility and mobility of He in single-crystal KBr were determined using three methods: (a) permeation, (b) He release after soaking, and (c) ion implantation. Permeation experiments give values for the activation energies of diffusion and permeation of 0.34−0.39 and 0.63 eV, respectively, and a heat of solution of 0.29 eV. Measurements of gas release from crystals implanted with 10^{16} He^+ ions/cm^2 at 300 keV yield an activation energy for gas release of ~0.6 eV. The diffusion in the undamaged crystal is interpreted as due to interstitial motion of the He atom. A very low solubility, on the order of 10^{14} He atoms cm^{-3} atm^{-1}, was determined in the range of 100−200°C, which is believed to be the first measured solubility of a rare gas in an alkali halide. Finally, it is shown that diffusion measurements such as those reported for an undamaged crystal are insensitive to traps if typical concentrations and reasonable trap depths are used. (auth)

60410 TEMPERATURE DEPENDENCE OF LUMINESCENCE OF F^+ AND F CENTERS IN CaO. Henderson, B. (Oak Ridge National Lab., Tenn.); Chen, Y.; Sibley, W. A. Phys. Rev., B; 6: No. 10, 4060-8(15 Nov 1972).

The principal moments of the F^+-center absorption and emission bands in CaO were studied as a function of temperature in the range 5 to 300°K. The absorption results are shown to be in excellent agreement with the very recent results of Escribe and Hughes. Moment analysis is less useful for emission than absorption bands and gives no further information about the nature of the dynamic Jahn−Teller effect in the excited state of the F^+ center. Nevertheless, certain features of the temperature dependence of the first four moments of the broad band shape indicate that the Jahn−Teller interaction is still important even though the luminescence process samples the orbitally nondegenerate ground state. Analysis of the results shows that in the range 5 to 78°K the moments $M_1(0)$ and $M_2(T)$ can be accounted for with an effective Huang−Rhys factor $S = 6$, the phonon modes effective in broadening the transition having a mean frequency $\hbar\omega = 273$ cm^{-1}. The first four moments of the $^3P \rightarrow {}^1S$ transition of the F center were measured between 5 and 300°K. The results are interpreted as being consistent with $S = 5.5$ and $\hbar\omega = 155$ cm^{-1}. Surprisingly, the band shape, as indicated by the ratio $R = M_4/(M_2)^2$, varies with temperature, being Gaussian below 90°K ($R = 3.1$) and rather asymmetric with $R < 3$ between 90 and 300°K. The experimentally measured line shapes in electron-irradiated crystals are well represented by Voigt profiles, which is interpreted as a convolution of the Gaussian component of the unirradiated crystal and that Lorentzian component due to point-defect broadening. The shape, shift, and broadening due to electron irradiation are qualitatively in agreement with the statistical theory of strain broadening. (auth)

60411 DEPENDENCE OF THE DISTRIBUTION OF DEFECTS INDUCED BY HEAVY PARTICLES ON THE RADIATION DOSE. Chernyak Yu. B.; Yakhot, V. S. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 112-15(1972). (In Russian).

The role of radiation-stimulated diffusion in the process of defect accumulation during irradiation is described. The phenomenon of spreading of the peak of defect formation with increased dose, which has been experimentally observed, is elucidated. (tr-auth)

60412 INFLUENCE OF NEUTRON IRRADIATION AT LOW TEMPERATURE ON INTERNAL FRICTION AND BULK MODULUS OF SILVER. Chountas, K.; Doenitz, W.; Papathanassopoulos, K.; Vogl, G. (Technische Univ., Munich). Phys. Status Solidi (b); 53: No. 1, 219-25(1 Sep 1972).

The internal friction and bulk modulus of silver were studied after irradiation at 25°K with fast neutrons. The Frenkel defects produced by irradiation cause dislocation pinning and a consequent decrease in the Bordoni internal friction peak. With increasing irradiation dose the bulk modulus first increases, reaches a maximum, and then decreases below its original value. The behavior of the modulus with annealing up to room temperature essentially corresponds to that of the residual electric resistivity after low-temperature neutron irradiation. A Frenkel defect concentration c_{FD} gives rise to a relative dielastic modulus decrease $\Delta G/G$ which was determined to be $\Delta G/(Gc_{FD}) = -33 \pm 9$. (auth)

60413 FERROMAGNETIC AFTER-EFFECT AT 55 K IN ELECTRON-IRRADIATED NICKEL. Schaefer, H. E.; Lampert, G. (Univ., Stuttgart). Phys. Status Solidi (b); 53: No. 1, 113-26(1 Sep 1972).

The ferromagnetic after-effect (MAE) was measured on high-purity nickel samples (resistivity ratio $R_{RT}/R_{4°K} > 2000$) that had been irradiated with 2.5-MeV electrons at 27°K with different doses and subjected to several annealing treatments. It was possible to separate the MAE from annealing effects taking place simultaneously. Taking into consideration annealing measurements of the MAE amplitude and the electrical resistivity published elsewhere, it is concluded that the 55°K-MAE and the corresponding recovery states I_D, I_E have to be attributed to the free diffusion of crowdions. (auth)

60414 ELECTRON-MICROSCOPE OBSERVATIONS OF DISLOCATION LOOPS AND RADIATION COLLOIDS IN LiF CRYSTALS. Natsvlishvili, G. I.; Politov, N. G.; Getts, S. F. (Inst. of Physics, Tbilisi, USSR). Sov. Phys.-Cryst. (Engl. Transl.); 17: No. 2, 301-5(1972).

Translated from Kristallografiya; 17: No. 2, 356-60(1972).

Point defects and their accumulations, dislocation loops, and radiation-thermal colloids in lithium fluoride crystals were studied by surface decoration with gold. Quantitative data were obtained on the density and nature of the distribution of defects in crystals subjected to annealing, quenching, deformation, irradiation in a reactor, and subsequent annealing. (auth)

60415 SOME FEATURES OF THE ELECTROLYSIS OF QUARTZ CRYSTALS IN AIR AND IN VACUUM. Chentsova, L. G.; Tsinober, L. I.; Samoilovich, M. I.; Kolodieva, S. V. Sov. Phys.-Cryst. (Engl. Transl.); 17: No. 2, 317-21(1972).

Translated from Kristallografiya; 17: No. 2, 374-8(1972).

A study of the infrared spectra of quartz crystals electrolyzed in air showed that such treatment causes alkali ions to be replaced as compensators by protons in a concentration proportional to the density of radiation-generated smoky color centers in these samples. Electrolysis of quartz in vacuum at temperatures above 650°C leads to the appearance of a thermally stable smoky color near the anode of the sample. The density of this coloration is also proportional to the initial concentration of radiation-generated centers. A study was made of the details of the optical absorption spectrum of quartz samples with coloring induced by electrolysis. (auth)

60416 SECONDARY SLIP OF A CESIUM IODIDE CRYSTAL GENERATED BY A POINT LOAD. Sizova, N. L. (Inst. of Crystallography, Moscow). Sov. Phys.-Cryst. (Engl. Transl.); 17: No. 2, 374-5(1972).

Translated from Kristallografiya; 17: No. 2, 428-31(1972).

An attempt was made to detect slip on secondary slip planes under conditions which suppress the main slip system $\{110\}\ \langle 100\rangle$. The etching pattern of the dislocation rosette rays was studied; decoration of these samples and of x-irradiated samples was also used. The secondary slip system is probably $\{110\}\ \langle 110\rangle$, in agreement with estimates of the ease of slip for various slip systems. (D.L.C.)

60417 RADIATION-INDUCED INTERCONVERSION OF COLOR CENTERS IN ADDITIVELY COLORED CaF_2, SrF_2, AND BaF_2 CRYSTALS. Zavadovskaya, E. K.; Baranov, A. I.; Lisitsyn, V. M.; Kalinin, M. I. Opt. Spectrosc. (USSR) (Engl. Transl.); 32: No. 2, 177-8(Feb 1972).

Translated from Opt. Spektrosk.; 32: No. 2, 335-7(Feb 1972).

Changes in the added absorption spectra of additively colored fluorite type crystals upon irradiation with various doses of 0.9-MeV electrons are investigated. Density changes of the irradiated crystals are recorded simultaneously. It is proposed that spectral and density changes of irradiated crystals can be explained by the formation of aggregate centers from F centers (CaF_2 and SrF_2) and of excited F centers (BaF_2). (auth)

60418 CHARACTERISTICS OF RECOMBINATION LUMINESCENCE OF PHOSPHORUS-ACTIVATED POTASSIUM HALIDES. Sushchkovskii, V. D.; Vasilev, I. A.; Mikhalchenko, G. A. Opt. Spectrosc. (USSR) (Engl. Transl.); 32: No. 2, 175-7(Feb 1972).

Translated from Opt. Spektrosk.; 32: No. 2, 331-4(Feb 1972).

The donor-acceptor properties of the luminescence center characterized by the formula PO_2 and the sign of the recombination process were studied in potassium halides activated with hypophosphorous acid. During irradiation with β particles, the accumulation of F centers in $KBr:PO_2$ is independent of the decrease of the activator in the crystal as a result of radiation destruction. The concentration of F centers produced by one and the same dose increases in crystals with a higher initial activator content. These results led to the conclusion that there is no competition between an anionic vacancy and a phosphorus center in capturing an electron, and that the activator traps are holes. The photostimulation of activator luminescence in the F band, the possibility of obtaining a low-temperature flare of radioluminescence, the results of parallel measurements of thermoluminescence, and stepwise depolarization of crystals irradiated at the liquid nitrogen temperature attest to the fact that the recombination process follows an electron—hole mechanism. (auth)

60419 BACKSCATTERING AND CHANNELING TECHNIQUES AS AN ANALYSIS METHOD FOR SURFACES AND THIN LAYERS. Meyer, O.; Linker, G. KFK Nachr.; 4: No. 2, 29-36(1972). (In German).

Based on experimental results during the past two years, various possibilities are discussed to use backscattering and channeling effects for determination of quality of crystals, lattice defects, and position of foreign atoms within the host lattice. Discussed are the implantation of ions into surface layers, physical properties of thin amorphous layers, and diffusion processes near surfaces. (H.B.G.)

60420 50-MeV ELECTRON IRRADIATION OF GERMANIUM DOPED WITH ^{57}Co. III. Matsui, Keiji (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 4: No. 2, 89-92(Feb 1972).

Conversion phenomena observed in 50-MeV electron-irradiated germanium doped with a ^{57}Co Moessbauer probe are reported in brief. The unresolved doublet found by Wertheim at +0.04 cm/sec appeared in all specimens, irrespective of their Fermi energies, prior to the irradiation, and converted to other spectra by the irradiation. A type of the conversion observed in a nearly intrinsic specimen is shown. As the Wertheim doublet is believed to arise from substitutional cobalt, a certain defect has to make a long-range migration in two hours. A different type of conversion was observed in 7-ohm · cm Sb-doped material. The spectrum was decomposed into the Wertheim doublet plus a singlet at +0.11 cm/sec, which corresponded to $Fe(int)^{+1\sim+2}$. The cobalt impurity detected by electrical or photoconduction measurement acted as a double acceptor. A different giant splitting structure, viz., ion pairs with low-spin d-electron configuration, was observed in 40-ohm · cm material. The splitting pairs disappeared in a few hours after the specimen was brought to room temperature, suggesting instability of the relevant ion pairs. (Japan)

60421 OPTICAL STUDY OF ION CRYSTALS BY USING PULSED ELECTRON BEAM. VI. Ueta, Masayasu; Hirai, Masamitsu; Kondo, Yasuhiro; Yoshinari, Takehisa (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 2, 90-5 (Dec 1970). (In Japanese).

The study was performed to investigate the relation between triplet-state excitation and F-center production, and to confirm the production mechanism of the F center. A KBr crystal was irradiated with the 30-MeV pulsed electron beam. Variation of photon absorption was measured at 80 ns, 300 ns, 2 μs, 50 μs, and 0.5 ms after the irradiation. Optical density results are shown. Absorption band peaks were seen at 1.58, 1.78, 2.06, and 3.23 eV. Decay time constant for the 1.58- and 1.78-eV bands was 130 μs, in agreement with the life of proper luminescence of KBr. The 2.06-eV band seems to be the F band. It is presumed that the 3.23-eV band is due to H center. Measurements on KI were also performed. A weak absorption band corresponding to the F band was observed as expected. The time constant for the triplet excitation band of NaCl was measured between 30 and 110°K. The absorption band seen at 610 mμ was confirmed to be due to the triplet excitation. Tentative mechanism of the production of F center from triplet state was considered. (Japan)

60422 PHOTOLUMINESCENCE IN GaAs IRRADIATED WITH ELECTRONS AT 77°K. Jeong, M. U.; Shirafuji, Junji; Inuishi, Yoshio (Osaka Univ., Suita, Japan). Technol. Rep. Osaka Univ.; 21: No. 973-994, 55-67(Mar 1971).

The annealing behavior of photoluminescence spectra at 77°K in electron-irradiated melt-grown n-GaAs was investigated. Several emission bands are resolved at 1.51, 1.47, 1.415, 1.305, and 1.2 eV. Electron irradiation (1.7 to 2.0 MeV) causes a remarkable decrease in emission intensity of all bands. Remarkable recovery of emission intensity occurs when samples are annealed to 520°K. The 1.415-eV peak appears clearly after irradiation and grows remarkably with the 520°K annealing, especially in Si-doped samples, resulting in large excess annealing. This band is tentatively speculated to be a complex of Si on As site with As vacancy. Moreover, in samples doped with Te a new emission band at 1.305 eV (9500 Å) is observed after 470°K to 620°K annealing. (auth) (Japan)

60423 NEAR SURFACE PROPERTIES OF QUENCHED X-IRRADIATED NaCl SINGLE CRYSTALS. Jarosz, B. (Technical Univ., Warsaw). Acta Phys. Pol.; A42: No. 2, 199-205(Aug 1972).

The distribution of crystal lattice defects was investigated in quenched and x-irradiated synthetic NaCl single crystals. Optical absorption in the 380 to 810 nm range, x-irradiation time dependence of optical absorption at 465 nm, and dislocation density were measured for the samples which were stored for several months in darkness. The results of these measurements indicate that the concentration of anion vacancies near the surface of the crystals is smaller than that in the bulk of the crystal. It is suggested that this effect is due to the higher concentration of OH^- impurity in the near-surface layers of the crystals than that in the bulk of the crystal. (auth)

60424 NATURAL AND LABORATORY α-PARTICLE IRRADIATION OF DIAMOND. Vance, E. R.; Milledge, H. J. (University Coll., London). Mineral. Mag.; 38: No. 299, 878-81(Sep 1972).

To produce a lattice expansion readily detectable by conventional x-ray photographic means in α-irradiated diamond, a dose of order 10^{18} $\alpha \cdot cm^{-2}$ is required. Such a dose could be produced by pitchblende in ~2×10^8 yr and a previously reported lattice expansion in a natural diamond could therefore have occurred by long-term contact with a radioactive material. α-particle doses greater than ~10^{14} cm^{-2} produce observable green colouration on the surface of an initially colourless diamond. (auth)

60425 BEHAVIOR OF OXYGEN IN IRRADIATED SILICON. Koval, Yu. P.; Mordkovich, V. N.; Temper, E. M.; Kharchenko, V. A. Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 12, 2061-2 (Jun 1972).

Translated from Fiz. Tekh. Poluprov.; 5: No. 12, 2352-4(Dec 1971).

A study was made of the effects of neutron bombardment and annealing on the infrared absorption in O-doped Si. The irradiated crystals had an absorption peak at 12 μ, due to A centers (vacancy–O complexes). After irradiation, the O content (measured at 8.7 μ) was lower than the initial content, and annealing at 100 to 250°C further decreased the O content. However, annealing at higher temperatures (≥600°C for the cooled irradiation and ≥800°C for the irradiation with no forced cooling) did not reduce but increased the O content. This is attributed to the dissociation of the second-phase SiO_2 particles and the conversion of O to the optically active state. (D.L.C.)

60426 AQUOLUMINESCENCE FROM γ-IRRADIATED CRYSTALS. PART III. EFFECTS DUE TO THALLIUM IONS AND WATER OF CRYSTALLIZATION. Arnikar, H. J.; Damle, P. S.; Chaure, B. D.; Deo, Vijaya (Univ. of Poona, India). J. Univ. Poona; No. 40, 11(1971).

An alternative mode of releasing, at room temperature, the energy stored in crystals colored by gamma radiation was recently observed. This involves destroying the crystal lattice of the irradiated salt simply by dissolution in water when the trapped electrons of the F centers become free to return to their normal positions (V centers) and to reform the original anions. This follows immediately on dissolution, the energy barrier being removed when all the ions are separated and hydrated. In this process, a faint bluish green glow extending into ultraviolet (named as aquoluminescence) is emitted. Further studies on substances like $SrCl_2$, $BaCl_2$, LiBr, CaI_2 show that the phenomenon is not restricted to alkali halides alone. Effects due to thallium ions, which act as an activator, on the glow intensity and the role of crystallization water, which hinders trapping and hence reduces the subsequent aquoluminescence, are discussed. (auth) (INIS)

60427 ON THE PECULIARITIES OF SILICON AMORPHIZATION AT ION BOMBARDMENT. Gerasimov, A. I.; Zorin, E. I.; Pavlov, P. V.; Tetelbaum, D. I. (Physical-Technical Research Inst., Gorky, USSR). Phys. Status Solidi (a); 12: No. 2, 679-85 (16 Aug 1972).

Pecularities of amorphous layer production in silicon under ion bombardment with middle-energy ions were examined by electron diffraction. ^{4}He, ^{11}B, ^{12}C, ^{14}N, ^{20}Ne, ^{31}P, ^{40}Ar, ^{75}As, and ^{131}Xe ion beams with energy of 50 keV were used. It was established that for light ions in a definite range of doses, two amorphous layers are formed—an external layer and an internal one (sandwich structure). Doses necessary for amorphization and the thicknesses of the amorphous layers were determined. Results are discussed in terms of a model connected with the radiation defect accumulation. It is shown that, for heavy ions, the amorphization doses and the thicknesses of amorphous layers agree with the calculated distribution and concentration of radiation defects, without taking account of their migration and annealing; for light ions under the given experimental conditions, it is necessary to take account of the decreasing of a number of defects in the zone of displacements due to their migration and (or) annihilation. (auth)

Physical Properties

Refer also to abstracts 58901, 59161, 59175, 59253, 59265, 59393, and 60190.

60428 (IS-T-528) MAGNETIC PROPERTIES OF HIGH PURITY SCANDIUM, YTTRIUM, LANTHANUM AND LUTETIUM AND THE EFFECTS OF IMPURITIES ON THESE PROPERTIES. Croat, John Joseph (Ames Lab., Iowa). Aug 1972. Contract W-7405-eng-82. 149p. Dep. NTIS.

Thesis.

Magnetic susceptibility measurements were carried out between 1.5 and 300°K using the Faraday method on single and polycrystalline specimens of Sc, Y, Lu, and dhcp La. Single-crystal measurements on Sc, Y, and Lu found χ_a greater than χ_c in all of the crystals. Good agreement was found between the polycrystalline and the weighted average of the single-crystal data for all three metals. While the magnetic susceptibility of Lu and Y are almost independent of temperature, Sc and La were found to have a significant negative temperature dependence. A maximum was observed at ~30°K in the susceptibility of Sc. A broad maximum was also found at 120°K in Lu. Sc was found to exhibit excellent Curie–Weiss behavior above 70°K. The effective moment and paramagnetic Curie temperature of polycrystalline Sc are 1.647 μ_B and –847°K. This μ_{eff} is close to what one would expect for an unpaired electron with spin only. Pure dhcp La also obeyed a Curie–Weiss relationship between 30 and 160°K. An effective moment of 0.580 μ_B was found over this temperature range. The θ was –216°K. An estimate of the susceptibility of pure fcc La is given. A study of the effects of impurities on the susceptibility of Sc was carried out. Small amounts of H_2 and O_2 lowered the susceptibility over the entire temperature range, with the decrease being fairly linear with solute concentration. Nonmagnetic metallic impurities (Group IVB, Group VB, and Th) were found to significantly decrease the susceptibility at high temperatures while increasing or only slightly decreasing the susceptibility at low temperatures. The susceptibility of the alloys could not be explained on the basis of a rigid band model because the change in χ was found to be strongly dependent on the atomic weight of the solute and independent of its valence. O_2 and H_2 were also found to lower the susceptibility of Y, La, and Lu. The effective moments and paramagnetic Curie temperatures of dilute Gd and Er in a Sc matrix were measured. In contrast to several recent studies, the values of μ_{eff} were found to be independent of concentration although slightly larger than the free ion values. This enhancement is believed to be due to polarization of the conduction electrons. (auth)

60429 KINETIC PROPERTIES AND ELECTRON SCATTERING MECHANISMS OF Ti, Zr, AND Hf AT HIGH TEMPERATURES. Zinov'ev, V. E.; Masharov, S. I.; Chupina, L. I.; Gel'd, P. V. (Ural Polytechnic Inst., Sverdlovsk, USSR). (Sov. Phys.-Solid State (Engl. Transl.); 14: No. 4, 902-5(Oct 1972).

Translated from Fiz. Tverd. Tela; 14: No. 4, 1053-7(Apr 1972).

The thermal diffusivity of titanium, zirconium, and hafnium was studied by the plane thermal-wave method in the 900 to 2500°K temperature interval. Published data were used to calculate thermal conductivity coefficients. The results obtained together with electrical resistance data are discussed on the basis of electron–phonon and electron–electron scattering in these metals allowing for the specific characteristics of their Fermi surfaces. It is shown that minor groups of electron states can be held responsible for the deviation of electric resistance from linearity and for the increase of thermal conductivity with temperature. (auth)

60430 TEMPERATURE DEPENDENCE OF POSITRON ANNIHILATION IN A METAL. Vorob'ev, A. A.; Aref'ev, K. P. (Tomsk Polytechnic Inst., USSR). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 4, 906-7(Oct 1972).

Translated from Fiz. Tverd. Tela; 14: No. 4, 1058-9(Apr 1972).

An analysis is made of the effect of heating on the angular distribution of annihilation γ's in a metal with an account of the thermal expansion of the metal. It is shown that the nature and magnitude of the changes in the correlation curves described by several investigators agree well with those calculated on the basis of the proposed model, so that the thermal-expansion coefficient of the metal can be measured. (auth)

60431 FERMI SURFACE OF CADMIUM UNDER PRESSURE. Galkin, A. A.; Degtyar', E. P.; Zhevago, S. E.; Popovich, A. I. (Donetsk Physicotechnical Inst., USSR). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 3, 787-8(Sep 1972).

Translated from Fiz. Tverd. Tela; 14: No. 3, 919-20(Mar 1972).

Magnetoacoustic oscillations (200 MHz, 1.6°K) in Cd at pressures up to 12 kbar were studied in order to find information on the topology of the Fermi surface of Cd. The period of the oscillations (period 1.69×10^{-7} Oe^{-1}) associated with the "pyramids" in the Fermi surface increases with pressure faster than that of oscillations (1.54×10^{-7} Oe^{-1}) associated with the "monster," indicating that the cross-sectional areas of these Fermi features decrease with pressure. In fields beginning at 30 kOe, quantum oscillations of period 0.615×10^{-7} Oe^{-1} were observed: in weak fields, resonance oscillations were observed whose reduction at 12 kbar was slight. (D.L.C.)

60432 MAGNETORESISTANCE OF GADOLINIUM AND HOLMIUM IN STRONG EFFECTIVE FIELDS. Galkina, O. S.; Lazareva, L. V.; Trubitsin, V. A. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 3, 655-7(Sep 1972).

Translated from Fiz. Tverd. Tela; 14: No. 3, 769-72(Mar 1972).

Results are given for an experimental study of the magnetoresistance of polycrystalline gadolinium and holmium in strong effective fields $H_{eff} = nH$ (where H is the external magnetic field and $n = \rho_{300°K}/\rho_{4.2°K}$ with H = 0). The temperature was 4.2°K and $H_{max} = 60$ kOe. It is shown that for large H_{eff} in these metals, the magnetoresistance begins to increase because the magnetic field affects the trajectories of the conduction electrons. For certain values of H_{eff}, $\Delta\rho/\rho$ changes sign and becomes positive. (auth)

60433 OPTICAL PROPERTIES OF V_2O_3 IN THE REGION OF THE PHASE TRANSITION. Kozyreva, M. S.; Novikov, V. N.; Tallerchik, B. A. Sov. Phys.-Solid State (Engl. Transl.); 14: No. 3, 639-43(Sep 1972).

Translated from Fiz. Tverd. Tela; 14: No. 3, 749-53(Mar 1972).

A study was made of the absorption and reflection spectra of single crystals of vanadium sesquioxide in the 0.05- to 6.0-eV region. The crystals were grown by the Verneuil method and had various degrees of deviation from stoichiometry. A change in the photon spectrum was observed with a change from the metallic to the semiconducting state. A plasma frequency clearly appears in the reflection spectra and was used to evaluate the effective mass of the free carriers. The dispersion of the real and imaginary parts of the dielectric constant was calculated from the reflection spectra, using the Kramers–Kronig relationship on a BESM-4 computer. It was determined that the energy spectrum of the 3d electrons consists of a series of narrow bands formed as a result of the splitting of the 3d level of the free V^{3+} ions by the V_2O_3 crystal field. (auth)

60434 EFFECT OF PRESSURE ON GALVANOMAGNETIC PHENOMENA IN RARE EARTH METALS. Vinokurova, L. I.; Kondorskii, E. I.; Rakhimova, Kh.; Ivanov, V. Yu. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 3, 613-19(Sep 1972).

Translated from Fiz. Tverd. Tela; 14: No. 3, 720-7(Mar 1972).

The effect of hydrostatic pressure of up to 10,000 kg/cm² on the Hall effect, electrical resistance, and the longitudinal galvanomagnetic effect $\Delta\rho/\rho$ in polycrystalline Gd and Tb samples was studied experimentally. The measurements were conducted in the 77 to 400°K temperature interval and in magnetic fields up to 22 kOe. The basic relationships characteristic of the Hall effect and $\Delta\rho$ at atmospheric pressure were found to be preserved under high pressure in the ferromagnetic and paramagnetic states. Pressure significantly affects the ordinary Hall coefficient R_0 in Tb and Gd; in the paramagnetic temperature interval, $[R_0^{-1}(\Delta R_0/\Delta p)]_{Gd} = -7.7 \times 10^{-5}$ cm²/kg, and $[R_0^{-1}(\Delta R_0/\Delta p)]_{Tb} = -4.2 \times 10^{-5}$ cm²/kg. No changes were observed in the extraordinary Hall coefficient R_p in the paramagnetic temperature interval within the limits of experimental accuracy. The Hall coefficients R_0 and R_s at $T < T_c$ were determined only for Gd, and the relative change in R_0 in Gd under pressure was found to be nearly the same above and below the Curie temperature. The temperature dependence of electrical resistance and of $\Delta\rho/\rho$ was measured with and without pressure applied; ρ and $\Delta\rho/\rho$, as well as the magnetic resistance ρ_m, were observed to decrease with pressure within the entire temperature interval. The results are discussed from the point of view of the band theory. (auth)

60435 STRUCTURE OF LEAD FILMS ON A TUNGSTEN (100) SURFACE. Gorodetskii, D. A.; Yas'ko, A. A. (Kiev State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 3, 636-8(Sep 1972).

Translated from Fiz. Tverd. Tela; 14: No. 3, 746-8(Mar 1972).

Low-energy electron diffraction was used to study the structure of lead films on a tungsten (100) surface. A P(2 × 2) structure was observed to transform to a C(2 × 2) structure when the lead concentration increased. Lead condensation in the second layer raised the work function and caused a P(1 × 2)–45° structure to form. The three-dimensional crystals were oriented with their (111) surface parallel to the substrate and were noticeably deformed in the thin films. The effect of annealing on the structure of lead films was studied. (auth)

60436 COERCIVITY OF SINTERED RARE-EARTH–COBALT MAGNETS. Tawara, Yoshio (Matsushita Electric Industrial Co. Ltd., Osaka). Jap. J. Appl. Phys.; 11: No. 10, 1578(Oct 1972).

An explanation is offered for the high coercive forces in liquid-phase-sintered rare earth–cobalt magnets. The RCo_5 grains are surrounded by an epitaxial shell of, e.g., R_2Co_7. An applied magnetic field moves domain walls in the RCo_5 grain into the shell where they are pinned. It is shown that a higher domain wall energy in the grain than that in the shell could account for the pinning without the need for imperfections such as proposed by Schweizer, Strnat and Tsui. Large coercive forces may be obtained if the shell compound has a smaller anisotropy than the grain compound, and if the epitaxial boundary is parallel to the c-axis. (D.L.C.)

60437 THERMOELECTRIC POWER OF DILUTE SOLID SOLUTIONS OF RARE-EARTH METALS IN SILVER AT LIQUID HELIUM TEMPERATURES. Bekker, F. F. (Univ., Amsterdam). Phys. Lett.; 41A: No. 4, 301-2(9 Oct 1972).

Thermoelectric forces of dilute Ag–RE alloys were measured between 1.6 and 6°K and analyzed in terms of phonon drag and diffusion contributions. The diffusion contribution is ascribed to a virtual d level and effects of crystal field splitting. (auth)

60438 ELECTRONIC STATE OF CERIUM IN SOME $CeRh_{3-x}Pd_x$ ALLOYS. Harris, I. R. (Univ. of Birmingham, Eng.); Norman, M.; Gardner, W. E. J. Less-Common Metals; 29: No. 3, 299-309(Nov 1972).

The room temperature lattice spacings and magnetic susceptibilities of some alloys represented by the general formula, $CeRh_{3-x}Pd_x$, were measured. The results indicate that in the composition range x = 0 to x = 2.36 (59% Pd*) the cerium atoms are in the four-valent state (the $4f^0$ configuration), whereas from x = 2.36 to x = 3 (75% Pd), the effective valency of the cerium atoms increases to a value of 3.45 at $CePd_3$ (the $4f^{0.55}$ configuration). The behavior of the magnetic susceptibility in this latter composition range suggests that the 4f electrons are not localized in character but can be described by a nonmagnetic, virtual bound state. (auth)

60439 MAGNETIC PROPERTIES OF VANADOUS OXIDE IN THE REGION OF HOMOGENEITY. Aivazov, M. I.; Gurov, S. V.; Sarkisyan, A. G. (Inst. of New Chemical Problems, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 2, 192-5(Feb 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 2, 213-16(Feb 1972).

The magnetic susceptibility of $VO_{1\pm x}$ specimens was investigated in the range 100 to 1100°K. It is suggested that defects in the vanadium sublattice lead to localization of d electrons and defects in the oxygen sublattice to antiferromagnetic pairing of electrons. On the basis of experimental results, it is suggested that the 2p states of oxygen form the zone of valence states; the 3d state of vanadium forms two subzones, separated by an energy gap. At high temperatures virtually all the d electrons are excited into the 1_g subzone, the degree of filling of which governs the character of the change in the magnetic state. (auth)

60440 QUANTUM OSCILLATION WAVEFORMS. Hoffman, A. R. (Univ. of Massachusetts, Amherst); Nelson, W. E.; Elterman, P.; Swartz, K. D. Phys. Lett.; 41A: No. 3, 233-4(25 Sep 1972).

Quantum oscillation waveforms were observed in an ellipsoidally shaped, high-purity beryllium sample. The theoretical prediction of a close relationship between $\partial M/\partial H$ oscillation waveforms and transport property waveforms is not confirmed. (auth)

60441 GALVANOMAGNETIC STUDIES OF THE FERMI SURFACE OF ZIRCONIUM. Everett, P. M. (Louisiana State Univ., Baton Rouge). Phys. Rev., B; 6: No. 10, 3553-9(15 Nov 1972).

The transverse magnetoresistance was traced in moderately high-purity samples of zirconium throughout the three symmetry planes in magnetic fields up to 57 kG. The Fermi surface was found to be compensated and no open orbits were observed. In addition, the even component of the sample voltage transverse to both current and magnetic field and the components transverse to the current and parallel to the magnetic field were found to vanish when both the magnetic field and current were along symmetry directions. (auth)

60442 DE HAAS–VAN ALPHEN STUDIES IN ZIRCONIUM. Everett, P. M. (Louisiana State Univ., Baton Rouge). Phys. Rev., B; 6: No. 10, 3559-69(15 Nov 1972).

The de Haas–van Alphen effect was studied in Zr in fields up to 57 kG. The five previously reported frequency branches were observed as well as two new ones. The symmetry-axis frequency values were determined with an uncertainty on the order of 0.1%, and the angular dependence of all the branches was firmly established. It seems unlikely that any Fermi-surface model presently available can account for these results. All but one of the cyclotron masses associated with these oscillations were measured at the symmetry axes. Except in one case, these mass values are greater than the free-electron mass. (auth)

60443 THEORY OF LATTICE DYNAMICS OF Nb_3Sn-TYPE COMPOUNDS. Sham, L. J. (Univ. of California, San Diego, La Jolla). Phys. Rev., B; 6: No. 10, 3584-92(15 Nov 1972).

A method is presented for calculating electron screening in the tight-binding approximation and constructing the dynamical matrix for the β-W compounds. It is shown that, in the cubic phase, no long-wavelength optical mode is temperature-dependent except Γ_{12} which has a weak temperature variation. By the method of long waves, the elastic constants, particularly $c_{11} - c_{12}$, are calculated as a function of temperature, with fair agreement with experiment. The cubic-to-tetragonal phase transition is inferred to be due to the instability of the $c_{11} - c_{12}$ shear mode, associated with which is a tetragonal distortion of Γ_{12} symmetry, in agreement with the neutron-scattering experiment of Shirane and Axe. (auth)

60444 LATTICE THERMAL CONDUCTIVITY AND DEVIATIONS FROM MATTHIESSEN'S RULE FOR DILUTE ALLOYS OF TIN WITH CADMIUM. Karamargin, M. C.; Reynolds, C. A.; Lipschultz, F. P.; Klemens, P. G. (Univ. of Connecticut, Storrs). Phys. Rev., B; 6: No. 10, 3624-33(15 Nov 1972).

The thermal and electrical conductivities of six single crystals of tin with cadmium (cadmium content ranging from 0.24 to 0.97 at. %) were measured from 4.2 to about 80°K. The lattice thermal conductivity was deduced for three of these samples of cadmium content in excess of 0.70 at. %, oriented close to 78° with respect to the tetragonal axis. Values of the ideal thermal resistivity of pure tin were needed to effect the separation into lattice and electronic components at higher temperatures, and it was assumed that deviations from Matthiessen's rule for thermal resistivity were governed by measured electrical-resistivity deviations and the Wiedemann–Franz law. The lattice thermal conductivity was analyzed in terms of phonon scattering by electrons, point defects, and anharmonic phonon interactions. Below 12°K the three samples gave a lattice thermal conductivity proportional to T^2 and of magnitude 1.5×10^{-4} T^2 W cm^{-1} K^{-1}, rising to a maximum of about 0.045 W cm^{-1} K^{-1} near 40°K. Deviations from Matthiessen's rule for the electrical resistivity were obtained for all six samples. These deviations show a T^2 dependence at low temperatures. This is inconsistent with a two-band model but suggests phonon-assisted impurity scattering. A theoretical difficulty associated with this mechanism is discussed. (auth)

60445 ELECTRONIC PHASE TRANSITIONS OF CERIUM METAL. Kiwi, Miguel (Univ., Chile, Santiago); Ramirez, Ricardo. Phys. Rev., B; 6: No. 10, 3700-6(15 Nov 1972).

The model recently proposed by Ramírez and Falicov is generalized by the incorporation of the spin–orbit splitting of the 4f shell. This generalization provides an understanding of the fractional valence and magnetic susceptibility of α-cerium and suggests a mechanism to drive the α-α' phase transition. (auth)

60446 AZBEL–KANER CYCLOTRON RESONANCE AND MAGNETIC SURFACE LEVELS IN BERYLLIUM. Kennedy, T. A.; Seidel, G. (Brown Univ., Providence). Phys. Rev., B; 6: No. 10, 3706-13(15 Nov 1972).

Azbel'–Kaner cyclotron resonance in beryllium was used to investigate the angular dependence of effective masses in the $(10\bar{1}0)$ and (0001) planes. The samples studied had a residual resistivity ratio of ~2000, producing at helium temperatures and 35 GHz values of $\omega\tau$ of approximately 10. Resonances were observed from belly and neck holes on the second-zone coronet and from electrons on the third-zone cigars. Where possible, results were compared with effective masses obtained in de Haas–van Alphen experiments. Surface-impedance oscillations due to magnetic surface levels were also observed at low magnetic fields and 35 GHz. Oscillations due to electrons of two different sections of the Fermi surface can be distinguished in angular studies in the $(10\bar{1}0)$ plane. One set of oscillations, centered about the $\langle 11\bar{2}0\rangle$, is ascribed to holes on the coronet necks. A second set, observed about the $\langle 0001\rangle$, is due either to holes on the ridge of the coronet belly or electrons on the ridge of the cigar waist. A comparison of the Fermi-surface parameters obtained in the surface-level experiments is made with known values for beryllium. (auth)

60447 ANOMALOUS ELECTRICAL RESISTIVITY IN TITANIUM–MOLYBDENUM ALLOYS. Ho, J. C.; Collings, E. W. (Battelle Memorial Inst., Columbus, Ohio). Phys. Rev., B; 6: No. 10, 3727-38(15 Nov 1972).

The results of resistivity measurements on Ti–Mo alloys of concentrations 5 to 20 at. % Mo are discussed. The experimental resistivity concentration dependence, which exhibits a pronounced local maximum near 8 at. % Mo, is compared with some calculated curves, derived with the aid of previously determined Fermi-density-of-states [$n(E_F)$] and Debye-temperature (Θ_D) data. On the assumption that the total resistivity is the sum of contributions due to thermal scattering (the ideal resistivity ρ_i) and solute scattering (ρ_s), the measured resistivity in the concentration range 5–15 at. % Mo is shown to be anomalously high. For a quenched alloy of composition near the middle of the above range, viz., Ti–Mo (10 at. %), the temperature dependence of resistivity ($d\rho/dT$) is negative between 4 and 480°K. But at higher temperatures $d\rho/dT$ is positive, and after being aged at 620°K the alloy assumes a normal positive $d\rho/dT$ over the full temperature range of 4 to 620°K. It is deduced that the anomalous magnitude, composition dependence, and temperature dependence are all associated in one way or another with an ω-phase precipitate (a small fraction of which is reversible or "athermal") occurring in the brine-quenched alloys within the composition range 5 to 15 at. % Mo. It is concluded, however, that the observed resistivity effects do not derive from intrinsic physical properties of the ω phase itself, but are due instead to electronic scattering from the interfaces between the precipitate particles and the matrix. Interfacial scattering associated with the irreversible (isothermal) ω phase is responsible for the anomalous isothermal resistivity, while the relatively small athermal ω-phase component gives rise to the negative $d\rho/dT$ exhibited by Ti–Mo (10 at. %). (auth)

60448 INFRARED ABSORPTION BY COUPLED SURFACE-PHONON–SURFACE-PLASMON MODES IN MICROCRYSTALS OF CdO. Rieder, K. H.; Ishigame, M.; Genzel, L. (Max-Planck-Institut fuer Festkoerperforschung, Stuttgart). Phys. Rev., B; 6: No. 10, 3804-10(15 Nov 1972).

The first observation of surface-phonon–surface-plasmon coupling in small particles is reported. Thin layers of semiconducting CdO microcrystals with various free-carrier concentrations were used as samples. The coupling manifests itself in the infrared-absorption spectra through two absorption maxima corresponding to two resonances of the coupled two-oscillator system and through a pronounced absorption minimum near the transverse-optical-phonon frequency ω_T. The experimental results are discussed on the basis of a theoretical approach recently developed by Genzel and Martin. Structure in the absorption spectra near the longitudinal-optical-phonon frequency ω_L is attributed to the strong polar-optical scattering of free carriers in CdO. (auth)

60449 LOW-ENERGY OPTICAL ABSORPTION IN ReO_3. Weaver, J. H.; Lynch, D. W. (Iowa State Univ., Ames). Phys. Rev., B; 6: No. 10, 3620-3(15 Nov 1972).

The absorptivity of polycrystalline samples of ReO_3 was measured in the range 0.11 to 2.8 eV using a calorimetric technique. New structures were found in the absorptivity, appearing at about 0.4 and 1.0 eV. The data were Kramers–Kronig analyzed to obtain the optical constants. Band-calculation results of Mattheiss are presented and a tentative identification of the origin of the new structures is made. A comparison of the present data with those of Feinleib, Scouler, and Ferretti is made. (auth)

60450 THEORY OF DIAMAGNETISM OF CADMIUM ALLOYS. McClure, J. W.; Martyniuk, J. (Univ. of Oregon, Eugene). Phys. Rev. Lett.; 29: No. 16, 1095-8(16 Oct 1972).

The contribution to the diamagnetism of cadmium coming from the region around the vertical edges of the Brillouin zone was calculated. The calculation consisted of the application of Fukuyama' formula to the Bennett–Falicov model. The results explain the types and magnitudes of the structures observed by Svechkarev and Kuzmicheva in the susceptibility curves of Cd–Mg and Cd–Hg alloys. (auth)

60451 BOUND MAGNETIC POLARONS AND THE INSULATOR–METAL TRANSITION IN EuO. Torrance, J. B.; Shafer, M. W.; McGuire, T. R. (IBM Thomas J. Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev. Lett.; 29: No. 17, 1168-71(23 Oct 1972).

A new model is presented for the insulator–metal transitions in Eu-rich EuO: At low temperatures the electrons are only very weakly bound to oxygen vacancies and conduction is metallic; near and above T_c the electrons localize and form bound magnetic polarons by ordering the Eu^{2+} spins neighboring the vacancy, thereby gaining exchange energy. Magnetic-susceptibility data are presented that support this model. (auth)

60452 CRYSTAL-FIELD EFFECTS IN THE MAGNETIC FORM FACTOR OF TmSb. Brun, T. O.; Lander, G. H. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 29: No. 17, 1172-5(23 Oct 1972).

The magnetic form factor of TmSb in an applied magnetic field of 12.5 kOe at 5°K was measured with polarized neutrons. The experimental points with $H \parallel \langle 100 \rangle$ fall on a smooth curve, whereas considerable anisotropy is observed with $H \parallel \langle 100 \rangle$. These effects arise from the interaction between the rare-earth ion and the crystal field. The agreement between the theoretical form factor, calculated by the tensor-operator method, and the experiment is excellent. (auth)

60453 PREPARATION OF MONOCRYSTALS OF NEODYMIUM OXIDE (Nd_2O_3) IN A PLASMA FURNACE: MAGNETIC PROPERTIES. Tueta, Roger (CNRS, Vitry-sur-Seine, France); Lejus, A. M.; Collongues, Robert; Bernier, J. C. Compt. Rend., Ser. C; 274: No. 23, 1925-8(5 Jun 1972). (In French).

Magnetic susceptibility measurements on Nd_2O_3 monocrystals prepared in a plasma furnace exhibit a significant anisotropy between 4 and 1000°K. The perpendicular susceptibility roughly follows a Curie–Weiss law, while the variation in the parallel susceptibility is explained by an evolution of the Nd^{3+} moment. (France)

60454 HALL EFFECT IN CADMIUM–MERCURY ALLOYS. Stringer, J.; Hill, J.; Huglin, A. S. (Univ. of Liverpool). Phys. Status Solidi (a); 13: No. 1, 67-71(16 Sep 1972).

The room-temperature Hall effect was determined in polycrystalline hcp Cd–Hg alloys in the composition range 0 to 14 at. % Hg. The extended cadmium-rich solid solution is of particular interest because the axial ratio increases with increasing mercury concentration to very high values in excess of 1.90, while the nominal electron-to-atom ratio remains constant. Within this composition range, the mean Hall effect, which is positive (hole-like), increases by approximately 30%, and although the Hall effect is known to be anisotropic in hcp metals, texture measurements indicate that no part of the increase can be attributed to changing contributions of the two components. A qualitative analysis suggests that both components must increase across the phase field. (auth)

60455 STEPWISE PHASE TRANSITIONS IN Ta_4D_3. Somenkov, V. A.; Chervyakov, A. Yu.; Shil'shtein, S. Sh.; Chertkov, A. A. Sov. Phys.-Cryst. (Engl. Transl.); 17: No. 2, 274-7(1972).

Translated from Kristallografiya; 17: No. 2, 323-7(1972).

Stepwise phase transitions of the order–disorder type in tantalum deuteride Ta_4D_3 were studied by neutron diffraction. Besides the transition with the "normal" superstructure vector $k = \pi(b_1^* + b_2^*)$, a phase transition characterized by the fractional superstructure vector $k = \pi(b_1^* + b_2^*)/2$ occurs below 250°K. (auth)

60456 CONDENSATION ON A MACROINHOMOGENEOUS SURFACE FOR EVAPORATION IN A VACUUM. Dorfman, V. F.; Toporovskii, S. A.; Kholmyanskii, V. A. (Inst. of Electronic Control Devices, Moscow). Sov. Phys.-Cryst. (Engl. Transl.); 17: No. 2, 331-4(1972).

Translated from Kristallografiya; 17: No. 2, 390-4(1972).

Condensation of cadmium and bismuth on macroinhomogeneous base layers was investigated. It was found that selective condensation on different regions of the base layer, depending on conditions, is possible. The observed patterns of growth are very complex. Mechanisms are proposed to account for the described phenomena. (auth)

60457 MAGNETIC STRUCTURE OF UPb_3. Leciejewicz, J. (Inst. of Nuclear Research, Warsaw); Misiuk, A. Phys. Status Solidi (a); 13: No. 1, K79-81(16 Sep 1972).

A neutron-diffraction study was made of UPb_3. The crystal structure of UPb_3 is of the $AuCu_3$ type. Neutron-diffraction patterns at 4.2°K showed two superstructure reflections, which were indexed on a unit cell of tetragonal symmetry with $a = a_0$ (= 4.793 Å) and $c = 2a_0$. The proposed magnetic structure consists of U magnetic moments aligned oppositely in adjacent (001) ferromagnetic places. The mean value of the magnetic moment is $1.7 \pm 0.1\ \mu_B$. The temperature dependence of one peak gives a Néel temperature of 32°K. (D.L.C.)

60458 REGULAR STRUCTURE OF Va TRANSITION METAL HYDROGEN-TYPE INTERSTITIAL ALLOYS. Asano, Hajime; Hirabayashi, Makoto (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 4: No. 2, 47-50(Feb 1972). (In Japanese).

A neutron-diffraction experiment was carried out to determine the crystal structure of β_2 phase and α phase of $TaD_{0.72}$. Samples for the measurements were encapsulated in a rectangular 5cm × 5cm × 1cm box and the measurements were performed in a high-temperature cryostat filled with argon gas. One of the results is shown in a figure. Reflections $h + k + l = 2n$ indexed by a cubic system with a = 3.44 Å were observed and are standard lattice reflections. Regular lattice reflections observed at room temperature were not observed. Possible structures were considered and the observed intensities were compared with calculated ones. The modifications of β_1, β_2, and α phases were considered to be due to regular and irregular modifications of deuterium atoms. Another neutron diffraction experiment was performed at room temperature and liquid-nitrogen temperature. Results for $VD_{0.50}$ and $VD_{0.71}$ are shown in figures. (Japan)

60459 NEUTRON-DIFFRACTION EXPERIMENT OF MAGNELLI-PHASE V_4O_7. Terasaki, Osamu (Tohoku Univ. Sendai); Watanabe, Denjiro; Yamada, Yukio. Kakuriken Kenkyu Hokoku; 3: No. 2, 80-1(Dec 1970). (In Japanese).

Intensity of neutron diffraction of vanadium oxide V_4O_7 was measured by the time-of-flight method, and results were compared with calculated intensity based on a structure model. The material was made by mixing V_2O_5 and V_2O_3 powder and enclosed in an aluminum capsule. Total irradiation dose of electron beam was 57 × 3000 μC. Measurement was performed at angles 30 and 90° at 190°K. Results are shown. Only two strong peaks were seen at 2.18 and 2.3 Å because of the small cross section of coherent scattering of vanadium and the short measuring time. It was impossible to discuss the crystal structure of V_4O_7 at low temperature from the present experiment. Vanadium oxide was not suitable to study the structure of Magnelli phase. As a further experiment, neutron diffraction on Ti_nO_{2n-1} is considered for the study of variation of the crystal structure following metal–semiconductor transition. (Japan)

60460 THERMAL-FIELD EMISSION FROM SINGLE CRYSTAL PLANES OF TUNGSTEN. Wysocki, J. (Univ., Wroclaw). Acta Phys. Pol.; A42: No. 2, 129-45(Aug 1972).

Thermal-field (T–F) emission from the (210), (421), (221), (211), (321), and (111) planes of tungsten was measured by means of a probe-hole FEM. The data were compared with the theories of Murphy-Good and Christov. A method of independent calculations of the work function φ and geometrical factor β is given. Results showed that for the T–F emission there is agreement between the experimental data and theory only for some single planes of the tungsten micromonocrystal; it does not exist for the whole tip. (auth)

60461 MAGNETIC SUSCEPTIBILITY AND EXPANSION COEFFICIENT OF THE INTERMETALLIC COMPOUNDS $YbAl_2$ AND $YbAl_3$. Iandelli, A.; Palenzona, A. (Univ., Genoa). J. Less-Common Metals; 29: No. 3, 293-7(Nov 1972).

Magnetic susceptibilities and lattice constants of the intermetallic compounds $YbAl_2$ and $YbAl_3$ were measured in the temperature range −180 to 550°C. $YbAl_3$ shows a behavior closely resembling that of an isomorphous trivalent $REAl_3$ compound, but $YbAl_2$ appears to contain a percentage of Yb(III) which increases with temperature. (auth)

60462 RESISTIVITY OF HIGH PURITY Nb FROM 20^0K TO THE TEMPERATURE OF FUSION. Abraham, J. M.; Deviot, B. (CNRS, Nancy). J. Less-Common Metals; 29: No. 3, 311-20 (Nov 1972). (In French).

Results of an electric resistivity study on various specimens are presented. High-purity specimens were obtained by degassing under ultrahigh vacuum. In particular, for the purest specimen: $R_{273.16^\circ}/R_{20.25^\circ} = 213$; this enabled accurate measurements to be made at low temperatures. Comparison between the specimens in the range of temperatures studied was carried out by using Matthiessen's rule at 77.35 and 273.15°K, whereby the resistivity of a specimen of large diameter was used as a reference. Matthiessen's rule was verified from 63 to 300°K. Results for the purest specimen are presented; these are lower than those found in the literature. For temperatures greater than 1500°K, a pronounced curvature was observed in the resistivity curve. (auth)

60463 SKEW SCATTERING OF THE ELECTRONS BY Ce IMPURITIES IN La. Fert, A.; Jaoul, O. (Paris Univ., Orsay, France). Solid State Commun.; 11: No. 6, 759-62(15 Sep 1972).

Low-temperature measurements of the Hall effect in lanthanum containing cerium impurities show, in addition to the ordinary Hall effect, a contribution (nearly) proportional to the magnetization of the cerium magnetic moments. This contribution is ascribed to skew scattering by the cerium impurities. The asymmetry of the scattering can result from the mixing of the conduction band and impurity wave functions for impurities having orbital magnetism. (auth)

60464 CRYSTAL-FIELD EFFECTS AND THE MAGNETIC PROPERTIES OF Pr. Hsieh, Y. Y.; Pink, D. A. (St. Francis Xavier Univ., Antigonish, Nova Scotia). Solid State Commun.; 11: No. 6, 783-5(15 Sep 1972).

The zero-temperature excitation spectra of the magnetic excitons in dchp praseodymium are derived in the RPA of the double-time Green function method. Bleaney's level scheme (Proc. Roy. Soc. (London) 276A: 39(1963)) is used to fit the experimental data. Susceptibilities are calculated and compared with measurements. (auth)

60465 GAS ADSORPTION BY REFRACTORY METAL SINGLE CRYSTALS. Ageikin, V. S.; Chuikov, B. A.; Ptushinskii, Yu. G.; Vas'ko, N. P. (Inst. of Physics, Kiev). J. Vac. Sci. Technol.; 9: No. 5, 1241-7(1972).

Results are considered of a mass-spectrometric investigation of the low-pressure oxygen interaction with surfaces of tungsten single crystals of different crystallographic orientation. It was established that oxygen thermodesorption occurs only in the form of unbound oxygen atoms (atomic phase) and a set of metal oxides (oxide phase), and that the oxygen quantities in the atomic and the oxide phases are comparable. A correlation is discussed between quantitative data on the surface concentration, the sticking probability and the adsorption heat of oxygen on tungsten, and the atomic structure of different faces of a single crystal. Correspondence between the composition of thermodesorption products and that of the adsorbed film is considered. Some data are also considered on the inhibition of the adsorption ability of the surface of the tungsten single crystal in respect to carbon monoxide or nitrogen when that surface is partially covered with electronegative or electropositive adatoms. Analysis of the results shows that the inhibition effect of the adsorption ability largely depends on the charge state of the adatoms and the electron structure of the adsorbed molecules. (auth)

60466 NIOBIUM ALLOYS AND COMPOUNDS. Neuberger, M.; Grigsby, D. L.; Veazie, W. H. Jr. Handbook of Electronic Materials, Volume 4. New York; Plenum Publishing Corporation (1972). 76p. $12.50.

Superconductivity applications are reviewed first, followed by data tables of physical, crystallographic, mechanical, thermal, electronic, magnetic, and optical properties for the alloys of Nb with the following elements: H, Au, Mg, B, Al, Sc, Ga, Y, In, Gd, C, Si, Ti, Ge, Zr, Sn, Hf, N, P, V, Sb, Ta, Bi, O, S, Cr, Se, Mo, Te, W, Tc, Re, Co, Rh, Ru, Pd, Os, Ir, Pt. ~400 references. (D.L.C.)

60467 METAMAGNETISM IN ErNiAl AND TmNiAl. Oesterreicher, H. (Oregon Graduate Center, Beaverton). Phys. Status Solidi (a); 12: No. 2, K109-10(16 Aug 1972).

Thermomagnetic analysis at 20 kOe shows ErNiAl and TmNiAl to order ferromagnetically at 15 and 12°K, respectively. In the paramagnetic region, the Curie—Weiss law is obeyed with Weiss temperatures of -1 and -11°K and effective magnetic moments of 9.8 and 7.8 μ_B for the Er and Tm, respectively. These effective moments correspond to the free tripositive rare earths and show that Ni is nonmagnetic in these compounds. S-type saturation develops in the magnetization at the lowest temperatures (4.2 and 1.6°K). Some minor hysteresis with no remanence left at zero field, typical of metamagnets, was observed. The S-type saturation relaxes just below the ordering temperature, suggesting a delicate balance between ferromagnetic and antiferromagnetic exchange interactions with the latter predominating at the lower temperatures. (D.L.C.)

60468 MAGNETIC STUDIES ON $TbNi_2$ AND $DyNi_2$. Oesterreicher, H.; Stanley, J.; Pitts, R. (Oregon Graduate Center, Beaverton). Phys. Status Solidi (a); 12: No. 2, K65-8(16 Aug 1972).

The magnetization mechanism of $TbNi_2$ and $DyNi_2$ was studied down to lower temperatures (1.6°K) and higher fields (46 kOe). Both magnetization curves show signs of saturation at 10 kOe, but the magnetization continues to rise even in the highest field. Extrapolated saturation values are 6.55 μ_B at 1.6°K and 6.32 μ_B at 4.2°K for $TbNi_2$ and 9.02 μ_B at 1.6°K and 8.88 μ_B at 4.2°K for $DyNi_2$. The cause of the low saturation magnetization is discussed. (D.L.C.)

60469 MAGNETIC PROPERTIES OF UAsY-TYPE COMPOUNDS (Y = S, Se, Te) IN ORDERED STATE. Bazan, C. (International Lab. for High Magnetic Fields and Low Temperatures, Wroclaw); Zygmunt, A. Phys. Status Solidi (a); 12: No. 2, 649-53 (16 Aug 1972).

The dependence of the magnetization for the ternary compounds UAsS, UAsSe, and UAsTe on temperature and magnetic field was investigated in the temperature range between 3°K and the respective Curie point in fields up to 80 kOe. Measurements were performed for both polycrystalline and single-crystal samples. In the latter case only the magnetization along the c-axis, being the easy one, was measured. All these compounds exhibit large anisotropy of the order 10^7 erg/cm^3. The average values of the magnetic moments of the uranium ion (1.1 to 1.4 μ_B) along the c-axis are smaller than those reported for other uranium compounds having similar crystal structure. Both UAsS and UAsSe have rectangular hysteresis loops in helium temperature region, with BH product of the order 10^7 erg. They also display unusual temperature variation of the magnetization, resulting probably from the temperature dependence of the magnetocrystalline anisotropy. (auth)

60470 BEHAVIOR OF DISLOCATIONS IN NIOBIUM UNDER STRESS. Ikeno, S.; Furubayashi, E. (National Research Inst. for Metals, Tokyo). Phys. Status Solidi (a); 12: No. 2, 611-22 (16 Aug 1972).

Single-crystal foils of pure niobium were stretched at room temperature within a transmission electron microscope operating at 500 kV, and formation mechanisms of the dislocation structure were studied. Under a stressed condition, dislocation lines of screw character showed curvatures much larger than those observed in the other bcc metals with high frictional stresses. The large curvatures were responsible for the dislocation behavior observed, e.g., the conservative motion of jogs or the strong dependence of debris formation on the foil orientation. It is also concluded that dislocation dipole clusters so far reported in pure bcc metals were originated from jogs, rather than from the trapping of dislocations with opposite signs. (auth)

60471 MAGNETIC PROPERTIES OF THE SUBSTOICHIOMETRIC URANIUM α-DICHALCOGENIDES UY_{2-x}. Suski, W.; Czopnik, A.; Mydlarz, T. (Inst. for Low Temperature and Structure Research, Wroclaw). Phys. Status Solidi (a); 12: No. 2, 525-31(16 Aug 1972).

Magnetic measurements on uranium α-disulfide and α-diselenide were performed in the temperature range 4.2 to 1000°K and in magnetic fields up to 80 kOe. A sharp maximum of the magnetization of α-USe_2 is found at the temperatures 8.5 to 12°K in magnetic fields below 15 kOe. A diffuse maximum is obtained for α-US_2 in the whole interval of the magnetic field at temperatures 10 to 35°K. Both the value of the effective magnetic moment (2.83 μ_B) in the temperature range 100 to 300°K and the value of the previously measured magnetic entropy are explained on the assumption that the ground state and the next excited state are singlets. (auth)

60472 DENSITY OF STATES AND CARRIER MOBILITY IN β-RHOMBOHEDRAL BORON. Berezin, A. A.; Golikova, O. A.; Moizhes, B. Ya.; Khomidov, T. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 5: No. 12, 2027-31 (Jun 1972).

Translated from Fiz. Tekh. Poluprov.; 5: No. 12, 2320-4(Dec. 1971).

An analysis was made of the experimental data on the electric conductivity, Hall effect, and thermoelectric power of β-rhombohedral boron samples with different carrier densities. These results were used in an approximate determination of the dependences of the density of states on the energy and of the carrier mobility on the energy and temperature. The density of states differed considerably from the standard parabolic dependence, whereas the carrier mobility increased with energy and decreased with temperature. It was concluded that carriers were strongly delocalized and that their motion was by a diffusion mechanism. These results are explained qualitatively by some features of the complex lattice of β-rhombohedral boron. (auth)

60473 LOW TEMPERATURE MAGNETIC PROPERTIES OF SOME URANIUM COMPOUNDS OF $AuCu_3$-TYPE STRUCTURE. Misiuk, A.; Mulak, J.; Czopnik, A. (Inst. for Low Temperature and Structure Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 20: No. 5, 459-61(1972).

Magnetic measurements on USi_3, UGe_3, USn_3, and UPb_3 were extended down to 4.2°K. The temperature-independent paramagnetism found in these compounds, except for UPb_3, confirms the nonmagnetic ground state of uranium proposed previously. For the latter compound, an antiferromagnetic transition at 32°K was observed. (auth)

60474 FIELD-ION MICROSCOPIC STUDY OF INTERSTITIAL PLASTICITY OF TUNGSTEN MICROCRYSTALS. Mikhailovskii, I. M.; Dranova, Zh. I. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 63: No. 2, 567-72(Aug 1972). (In Russian).

Plastic deformation of tungsten needlelike microcrystals was investigated at temperatures between 21 and 80°K. It was found that, under the action of stresses close to the theoretical tensile strength, plastic deformation that is related to the formation and diffusion of interstitials may be possible. Disordering in microcrystals bombarded by low-energy He ions is observed. The formation mechanism of crowdions on nonconservative movement of dislocations is considered. Suppression of tungsten plasticity on lowering of the temperature to 20°K is ascribed to crowdion slowing down of the dislocations. (auth)

60475 EFFECT OF IMPURITIES ON THE RESIDUAL ELECTRIC RESISTANCE OF CADMIUM. Aleksandrov, B. N.; Dukin, V. V. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 63: No. 2, 648-59(Aug 1972). (In Russian).

The degree of influence of fifteen impurities (Pb, Sn, Pd, Rh, Ge, Pt, Tl, Au, In, Ga, Ag, Cu, Mn, Hg, Zn) on the residual resistance, ρ_0, of cadmium was studied. The alloys were prepared with 99.9999% pure cadmium possessing $\rho_0/\rho_{293} = (1 \text{ to } 2) \times 10^{-5}$ and impurity concentrations ranging from 2×10^{-4} to 2%. Homogenizing annealing treatments at 250 to 280°C were carried out in helium for at least 14 days. It is demonstrated that the Linde rule holds only for impurities of the V period (which includes cadmium). For impurities of the IV and VI periods, the dependence $\Delta\rho/c = a(\Delta Z)^2 + b\Delta Z + d$ is valid, the coefficient a increasing with growth of period number. A calculation of $\Delta\rho/c$ for normal metals by the phase shift technique yields satisfactory agreement with the experimental values. Allowance for lattice distortion by impurity atoms does not improve the agreement. The limits of solubility of In, Cu, Tl, Rh, Pd, Ga, Sn, Pt, Ge, and Pb in cadmium at 250°C are estimated. It is found that for Ni, As, and Sb the solubilities are $(1 \text{ to } 2) \times 10^{-3}\%$ and for Mn it is $\leq 0.1\%$. (auth)

Moessbauer Effects and NMR

60476 (LBL-1210) HIGH-RESOLUTION MOESSBAUER SPECTROSCOPY WITH ^{181}Ta. Kaindl, G.; Salomon, D. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1972. Contract W-7405-eng-48. 25p. (CONF-720834-1). Dep. NTIS.

From International conference on applications of the Moessbauer effect; Galilee, Israel (27 Aug 1972).

The 6.2-keV γ resonance of ^{181}Ta can no longer be considered as an exotic case with limited applications. If experimental problems can be surmounted, its superior resolution may be of great use for the study of subtle solid-state effects. This was demonstrated especially by the temperature shift results, where the effects caused by hyperfine interaction were found to be dominating over the thermal red shift. The present resolution is obtained with experimental linewidths typically of the order of 20 to 100 times the natural linewidth. Even though many applications of its unique features may be achieved with the present linewidths, an improvement is definitely of great interest. (auth)

60477 CHARACTER OF ELECTRON-NUCLEAR INTERACTIONS IN METAL-HYDROGEN SYSTEMS BASED ON TRANSITION METALS OF GROUP IVb. Khodosov, E. F.; Shepilov, N. A. (Donetsk Physicotechnical Inst., USSR). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 3, 807-8(Sep 1972).

Translated from Fiz. Tverd. Tela; 14: No. 3, 939-40(Mar 1972).

The spin-lattice relaxation of TiH_x, ZrH_x, HfH_x, and TiH_x-ZrH_x was studied at 77 and 295°K for the rigid-lattice case to obtain the electron contribution T_{1e}. The products $T_{1e}T$ are constant with temperature except for TiH_x compounds (x = 1.495, 1.62, and 1.7) not satisfying the rigid-lattice condition. Results lead to the following conclusions: The electron-nuclear interaction is a hyperfine one between the conduction electrons at the top of the Fermi distribution and the proton spins. For Ti, the hyperfine interaction is intensified with increasing H content, while for Zr and Hf, it is diminished with increasing H content. (D.L.C.)

60478 AZIMUTHAL DEPENDENCE OF THE PURELY NUCLEAR DIFFRACTION FOR 14.4-keV RESONANT GAMMA RAYS. Mirzababaev, R. M.; Sklyarevskii, V. V.; Smirnov, G. V. (Inst. of Atomic Energy, Moscow). Phys. Lett.; 41A: No. 4, 349-50(9 Oct 1972).

An azimuthal dependence of the intensity of the resonant gamma-ray nuclear Bragg reflection from a sodium nitroprusside single crystal was observed. The dependence reflects the structure of the electric field inside the crystal. (auth)

60479 ELECTRON PARAMAGNETIC RESONANCE OF Cr^+ IN MgO. Rius, G.; Herve, A. (CEN, Grenoble, France). Solid State Commun.; 11: No. 6, 795-7(15 Sep 1972).

Observations were made of the EPR spectrum of the Cr^+ ion with cubic symmetry in MgO crystals irradiated with γ rays at 77°K. The spectroscopic g-factor, cubic field splitting, and hyperfine constant are respectively: $g = 1.9996 \pm 0.0005$; $3a = (123.8 \pm 7.2)\ 10^{-4}\ cm^{-1}$; and $|A_{Cr^+}| = (17.6 \pm 0.2)\ 10^{-4}\ cm^{-1}$. (auth)

60480 MOESSBAUER EFFECT DATA INDEX. Covering the 1970 Literature. Stevens, J. G.; Stevens, V. E. (eds.). New York; Plenum Publishing Corporation (1972). 376p. $29.50.

This volume, similar in format to its predecessors, made extensive use of computer programming in the literature searches. Chemical Abstracts' Source Index was made the judge of what would or would not be included. Besides the data and the references (over 1000), appendices are included to facilitate the use of the index. Papers on ^{57}Fe and ^{119}Sn Moessbauer spectroscopy and electric quadrupole interactions are presented. In addition to the index and the topical reference lists, a 1969 addendum reference list, a 1970 master reference list, a 1970 author index, and a 1971 partial reference list are also included. (D.L.C.)

60481 COMPUTER SIMULATION OF MOESSBAUER SCATTERING SPECTRA. Groves, J. L. (Univ. of Illinois, Urbana). Comput. Phys. Commun.; 3: No. 4, 339-50(Jul 1972).

A FORTRAN computer program for simulating Moessbauer scattering spectra for large scatterers and large detectors was written. The intensities and energies of the allowed transitions are calculated, and the scattering spectrum as a function of the angles locating the scatterer and detector is determined. The spectrum is then numerically integrated over the solid angles subtended by the scatterer and detector. The simulated spectra are restricted to an axially symmetric source-scatterer-detector arrangement, and the hamiltonian describing the hyperfine interactions of the Moessbauer nuclei with external fields must be diagonal in the $|IM\rangle$ representation. (auth)

Theory

Refer also to abstracts 60443 and 60485.

PHYSICS (THEORETICAL)

Refer also to abstracts 59622, 59726, 59759, 59939, 59952, and 59979.

60482 (CNRS-CPT-72-P-452) GAUGE TRANSFORMATIONS OF SECOND TYPE AND THEIR IMPLEMENTATION. I. FERMIONS. Gille, J. F.; Manuceau, J. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Mar 1972. 17p. Dep. NTIS (U. S. Sales Only).

A necessary and sufficient condition for implementation of some local gauge transformations in a class of irreducible representations of the C.A.R.-algebra is proved. Some particular results on the unitary group of implementation are then given. (France)

60483 (CNRS-CPT-72-P-457) FINITE GROUP VELOCITY OF QUANTUM SPIN SYSTEMS. Lieb, Elliott H.; Robinson, Derek W. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Apr 1972. 13p. Dep. NTIS (U. S. Sales Only).

It is proved that there exists a finite bound for the group velocity of a system with finite range interaction. (France)

60484 (WAPD-TM-1038) ESTIMATION OF ACCELERATION PARAMETERS FOR THE CHEBYSHEV POLYNOMIAL AND THE SUCCESSIVE OVERRELAXATION ITERATION METHODS. Hageman, L. A. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jun 1972. Contract AT-11-1-GEN-14. 88p. Dep. NTIS.

The successive overrelaxation (SOR), the Chebyshev polynomial (CP), and the cyclic Chebyshev polynomial (CCP) iteration procedures require the use of acceleration parameters which must be properly chosen to obtain optimum rates of convergence. Numerical methods for estimating these acceleration parameters are specified, discussed, and numerically compared. The methods presented obtain estimates for the optimum parameters by examining the residual vectors and the convergence properties of the SOR or Chebyshev iterations when various values of the acceleration parameters are used. (auth)

60485 MANY-BODY PROBLEM. Khalvasi, Kh. T. (Tbilisi State Univ., USSR). Phys. Lett.; 41A: No. 4, 380(9 Oct 1972).

The interaction of a charged particle, passing through a substance, with the charged particles (electrons and ions) of the substances is studied. A short-range Yukawa type potential is taken as the interaction potential. The corresponding Schrödinger equation is solved in momentum space and the particle wave functions are obtained. (auth)

60486 COHERENT STATES OF ROTATING BODIES. Makhviladze, T. M.; Shelepin, L. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 15: No. 5, 1082-5(May 1972). (In Russian).

A possibility of a generalization of coherent states to systems with a nonequidistant spectrum is considered for the rotating bodies. In contrast with the oscillator case, there is not a total classical image for the generalized states which are interpreted as being maximally close to classical ones. However, a number of classical properties are retained (in particular, the existence of a classical angular momentum vector at any instant of time). In this case, the uncertainty relations between angular momentum components are minimized. (auth)

60487 ADIABATIC THEOREM FOR VARIATIONAL WAVE FUNCTIONS. Epstein, S. T. (Oxford Univ.). J. Phys., B (London); 5: No. 4, 741-5(Apr 1972).

It is shown under rather general conditions that variational wave functions satisfy an adiabatic theorem. (auth)

60488 INTERPOLATION THEORY FOR QUANTUM MECHANICS. Morris, M. J. (University Coll. of South Wales, Cardiff, Eng.). J. Phys., A (London); 5: No. 4, 489-94(Apr 1972).

Methods for finding the energies and eigenstates of the Hamiltonian $H(\lambda) = (1 - \lambda)H_0 + \lambda H_1$ which smoothly interpolate between the limits $\lambda = 0, 1$ are given. (auth)

60489 HIDDEN-VARIABLE THEORIES AND BELL'S INEQUALITY. De La Pena, L.; Cetto, A. M.; Brody, T. A. (National Univ. of Mexico, Mexico City). Lett. Nuovo Cim.; 5: No. 2, 177-81(9 Sep 1972).

Bell's inequality for the correlations among measurements has been interpreted to imply that a hidden-variable theory, in order to reproduce all the results of quantum mechanics, must contain in an essential way nonlocal variables. Bell's inequality is re-interpreted, in order to show that there is no conflict with possible local hidden variable theories, and to indicate under what conditions Bell's inequality would be expected to hold. (L.B.S.)

60490 EXACT SOLUTION OF THE EQUATION OF MOTION OF A CHARGED PARTICLE. Gilkman, L. G. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 4, 558(Oct 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 4, 708(Apr 1972).

An exact solution of the equation of motion of a charged particle in a uniform axially symmetric magnetic field has been found for the case in which the field time-dependence is given by $H(t) = [(H_1t^k + H_2)/t^2]^{1/4}$, where H_1, H_2, and k are constants. (auth)

60491 TRANSITION MOMENT INTEGRALS AND THE HYPERVIRIAL THEOREM. I. Coulson, C. A.; Nash, J. C. (Oxford Univ.). J. Phys., B (London); 5: No. 5, 921-6(May 1972).

Hypervirial theorems are used to derive a differential equation for the transition-moment generating function $\langle A/\exp(itx)/B\rangle$ associated with eigenstates A and B in a one dimensional wave-mechanical system. Explicit solution of the equation is possible for the harmonic oscillator, and leads to a simple expression for the overlap integral between two similar oscillators on different centers. (auth)

60492 ASYMPTOTIC COMPLETENESS FOR MULTI-PARTICLE SCHROEDINGER HAMILTONIANS WITH WEAK POTENTIALS. Iorio, Rafael Jose Jr.; O'Carroll, Michael (Pontificia Univ. Catolica, Rio de Janeiro). Commun. Math. Phys.; 27: No. 2, 137-45(1972).

It is shown that the nonrelativistic quantum mechanical n-body Hamiltonians $T(k) = T + kV$ and T, the free particle Hamiltonian, are unitarily equivalent in the center of mass system, i.e., $T(k) = W_\pm(k)TW_\pm(k)^{-1}$ for k sufficiently small and real. $V = \sum_i V_i$, a sum of $n(n - 1)/2$ real pair potentials, V_i, depending on the relative coordinate $x_i \epsilon R^3$ of the pair i, where V_i is required to behave like $|x_i|^{-2-\epsilon}$ as $|x_i| \to \infty$ and like $|x_i|^{-2+\epsilon}$ as $|x_i| \to 0$. T(k) is the self-adjoint operator associated with the form sum T + kV. There are no smoothness requirements imposed on the V_i. Furthermore $W_\pm(k) = \text{s-}\lim_{t\to\pm\infty} e^{iT(k)t}e^{-iTt}$ are the wave operators of time dependent scattering theory and are unitary. This result gives a quantitative form of the intuitive argument based on the Heisenberg uncertainty principle that a certain minimum potential well depth and range is needed before a bound state can be formed. This is the best possible long range behavior in the sense that if $kV_i \leqq C_i|x_i|^{-b}$, $0 < b \leqq 2$ for $|x_i| > R_i (0 < R_i < \infty)$ and all C_i are negative then T(k) has discrete eigenvalues and $W_\pm(k)$ are not unitary. (auth)

60493 EXACT SOLUTION OF THE DIRAC EQUATION WITH A CENTRAL POTENTIAL. Kanellopoulos, E. J.; Kanellopoulos, Th. V.; Wildermuth, K. (Univ., Tuebingen, Ger.). Commun. Math. Phys.; 27: No. 2, 155-61(1972).

The exact solution of the Dirac equation with a central potential, in the semi-relativistic approximation, is derived, and formulas for phase shifts and eigenvalue equations are given. (auth)

60494 INDUCED RADIATION OF POLARIZED ELECTRONS BY IONS IN THE FIELD OF A PLANE ELECTROMAGNETIC WAVE. Klimenko, Yu. I.; Khalilov, V. R. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 1, 73-80(1972). (In Russian).

The induced, retarding effect that arises during the scattering of polarized electrons by ions possessing a magnetic field was examined in the presence of an electromagnetic wave. The effect of the polarization of the electrons on scattering was analyzed. Certain particular cases of the induced effect are given special attention. (tr-auth)

60495 SOLUBLE ONE DIMENSIONAL MODEL OF AN INTERACTING FERMI GAS. 1. Witteles. E. M. (Univ. of Bar-Ilan, Ramat-Gan, Israel); Carmi, G. J. Phys., A (London); 5: No. 5, 612-23(May 1972).

A one dimensional model system of fermions is studied, which proves to be exactly soluble in the thermodynamic limit. It is shown that the thermodynamic functions for the model system are the same as for a system of noninteracting fermions in a harmonic oscillator well. As a special case of the model system, with a particular choice for the coupling constant, it reduces to a particular two-species system of fermions interacting via pairwise harmonic forces. For this case of the two-species system the free energy per particle, the pressures, the specific heat at constant volume and the isothermal compressibility are calculated in the canonical ensemble in closed form. It is shown that this system does not undergo a phase transition. (auth)

60496 MANY-PARTICLE SYSTEMS. Hall, R. L. (Queen's Univ., Kingston, Ont.). J. Phys., A (London); 5: No. 5, 608-11(May 1972).

An energy lower bound method of Carr and Post (J. Phys. A. Gen. Phys. 4 665-78 (1971)) incorporates the full permutation symmetry of the N particle system, but the resulting estimates for the ground state energies appear to be inferior to those given by a method of Hall and Post (Proc. Phys. Soc. 90: 381-96 (1967)) for small N, and to a method of Hall (Proc. Phys. Soc. 91: 16-22 (1967)) for large N. (auth)

60497 TWO-PARTICLE GREEN FUNCTION SELF-ENERGY EXPANSION. Lee, R. (Imperial Coll. of Science and Tech., London). J. Phys., A (London); 5: No. 7, 950-64(Jul 1972).

The two-particle self-energy operator is derived. The method is an extension of the Kadanoff and Baym method (Phys. Rev. 124: 287-99 (1961)) for the one-particle self-energy operator. The self-energy is then expanded to illustrate the similarities and differences with the one-particle case. An example is used to study the structure of the expansion. In conclusion a brief discussion of the one-particle method to derive the two-particle Green function is given. (auth)

60498 LINEAR INTEGRAL EQUATIONS. THEORY AND TECHNIQUE. Kanwal, Ram P. New York; Academic Press Inc. (1971). 305p. $16.50.

Many physical problems that are usually solved by differential equation methods can be solved more effectively by integral equation methods. Types of solutions of particular use in applied mathematics, theoretical mechanics, and mathematical physics are discussed. After a brief introduction, the following topics are covered: integral equations with separable kernels, method of successive approximations, classical Fredholm theory, applications to ordinary and partial differential equations, symmetric kernels, singular integral equations, integral transform methods, applications to mixed boundary-value problems, and integral equation perturbation methods. (11 figures) (R.W.R.)

60499 ENERGY LEVELS OF THE ANHARMONIC OSCILLATOR. Mathews, P. M.; Eswaran, K. (Univ. of Madras). Lett. Nuovo Cim.; 5: No. 1, 15-18(2 Sep 1972).

A simple approximate formula is derived for calculating the eigenvalues E_n of the Hamiltonian for the anharmonic quantum oscillator. The formula has scaling properties identical to those of the exact eigenvalues. (L.B.S.)

60500 EXPECTATION VALUE IN GAMOW STATE. Gyarmati, B.; Krisztinkovics, F.; Vertse, T. (Inst. of Nuclear Research, Debrecen, Hungary). Phys. Lett.; 41B: No. 2, 110-12 (18 Sep 1972).

The expectation value of r^2 in the Gamow states of a square-well-plus-square-barrier model was calculated. The results seem to justify the way Berggren has generalized the definition of the expectation value from bound state to quasi-bound state. (auth)

60501 QUANTUM MECHANICAL STATE PREPARATION: A SIMPLE MODEL. Park, J. L.; Band, W. (Washington State Univ., Pullman). Int. J. Theor. Phys.; 6: No. 1, 9-29(Aug 1972).

Quantum dynamics is normally used to describe the causal evolution of the quantum state of a physical system between initial acts of preparation and final measurement operations. But logical consistency and completeness require that the same dynamical principles be applicable to the physical description of the preparation and measurement process themselves. There is an extensive literature of contributions to the quantum theory of measurement, but very little theoretical scrutiny has been given to the process of state preparation. A philosophical analysis of the concept of preparation in quantum physics is given, a classification of preparation schemes into selective and coercive types is then developed. An exact mathematical model illustrating coercive preparation is presented in detail. (auth)

60502 QUANTIZATION IN GENERALIZED COORDINATES. II. Gruber, G. R. (Hofstra Coll., Hempstead, N. Y.). Int. J. Theor. Phys.; 6: No. 1, 31-5(Aug 1972).

In a previous article (Gruber, (Foundations of physics. 1, 3; 227. (1971)) it was considered what the operator form of the generalized canonical momenta was in quantum mechanics. Pauli (1950), through a different method, found what the generalized momentum operator was also, and both results were in agreement. However, the prescription of incorporating the momentum operator into the Hamiltonian, in some cases does not give the correct form of the Hamiltonian operator. It is found exactly how to incorporate the total momentum operator $pq_i = i\hbar\delta/\delta q_i$ into the generalized classical Hamiltonian to get the correct quantum mechanical Hamiltonian operator for all cases. A clear-cut way is shown of making the transition from classical observable functions of the canonical momenta to their quantum mechanical operator analogs in generalized spaces. (auth)

60503 NON-HAMILTONIAN MODEL OF THE HARMONIC OSCILLATOR. Fronteau, J.; Jacquier, R. Ann. Inst. Henri Poincare, Sect. A; 16: No. 2, 119-32(1972). (In French).

Attempts to interpret quantum levels as limit cycles led to the suggestion of a nonlinear dissipative model capable of describing all the energy levels of the harmonic oscillator. (France)

60504 QUANTUM THEORY WITHOUT THE SUPERPOSITION PRINCIPLE. Shapiro, I. S. (Inst. of Theoretical and Experimental Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 3, 139-42(5 Aug 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 3, 197-200(5 Aug 1972).

It is shown that a probabilistic interpretation of the wave function and of the transition amplitudes is possible in a theory that violates the superposition principle. It is also shown that in such a theory there exist real conserved physical quantities (energy, momentum, and angular momentum) which are connected as usual with the symmetry properties of space–time. This is illustrated by an example of systems with a finite number of degrees of freedom. (J.F.P.)

60505 NON-RELATIVISTIC APPROXIMATION OF THE THEORY OF THE PARTICLE OF SPIN MAXIMUM 1. Pereira, J. V. (Centre National de la Recherche Scientifique, Paris). Int. J. Theor. Phys.; 6: No. 2, 155-64(Aug 1972).

It is shown that the method of fusion still remains true within the frame of nonrelativistic wave mechanics, since it provides the equations describing the fusion of two corpuscles of Pauli in the nonrelativistic equations of evolution of the particles with spin maximum 1 and charge q. The nonrelativistic formalism of the theory is studied. (UK)

60506 HIDDEN VARIABLES AND 2-DIMENSIONAL HILBERT SPACE. Bugajska, Krystyna; Bugajski, Slawomir. Ann. Inst. Henri Poincare, Sect. A; 16: No. 2, 93-102(1972).

It is shown on the basis of Gleason's theorem that a hidden-variable model of standard quantum mechanics is impossible except for quantum systems which can be described in 2 dimensional Hilbert space. Two existing hidden parameter models for a spin $1/2$ particle are analyzed. It is demonstrated that the hidden pure states of this model are merely measurements of probability in the logic associated with a 2 dimensional Hilbert space. The unusual richness of this set of probability measurements enables many similar models to be constructed; an example of such a construction is given. (France)

60507 RELATIVISTIC GRAND ORBITAL MOMENTUM IN CLASSICAL THREE-BODY SYSTEMS. Dziembowski, Z. (Univ., Warsaw). Acta Phys. Pol.; B3: No. 4, 513-23(1972).

Using a suitable normalized coordinate system the Hamiltonian for N-free relativistic spinless particles may be written in the following form $H = \sqrt{(\sum_{\alpha=1}^{N} m_\alpha)^2 + \sum_{\alpha=1}^{N} \pi_\alpha^2}$. A generalized Poincaré group is identified as a group of symmetry of the system. The relativistic grand orbital momentum tensor Γ_{ij} (i,j = 1, 2, ..., 3N−3) is defined, and its connection with the many-body impact parameter—b has the following simple form $\Gamma^2 = b^2[M^2-(\sum_{\alpha=1}^{N} m_\alpha)^2]$, where M is the total invariant mass of the system, and $\Gamma^2 = \frac{1}{2}\Sigma(\Gamma_{ij})^2$ is Poincaré invariant. The whole scheme is presented for a three particle system, but can be easily generalized to N > 3. (auth)

60508 TREATMENT OF CONSTANTS OF MOTION IN THE VARIATION PRINCIPLE: SYMMETRY PROPERTIES OF VARIATIONAL WAVE FUNCTIONS. Laskowski, Bernard (State Univ. Center Antwerp); Loewdin, Per-Olov. Chem. Phys. Lett.; 16: No. 1, 1-4(15 Sep 1972).

In connection with the Schroedinger equation $H\Psi = E\Psi$, the approximate eigenfunctions Φ situated within a subspace M are studied by means of the variation principle $\delta\langle H\rangle = 0$. It is shown that, if the hamiltonian H has a normal constant of motion Λ or a group $G = \{g\}$ of such constants, and if the subspace M is stable under Λ or the group $G = \{g\}$, then the variational solutions Φ show exactly the same type of symmetry properties as the exact eigenfunctions. (auth)

60509 PERTURBATION THEORY OF THE PATH-INTEGRAL FORMALISM OF THE NONRELATIVISTIC QUANTUM MECHANICS. APPLICATION TO THE HYDROGEN ATOM AND THE HARMONIC OSCILLATOR. Goovaerts, M. Ghent; Ghent Rijksuniversiteit (1971). 120p. (In Dutch).
Thesis.

The path-integral formalism of Feynman is developed. Analytical solutions of the energy spectra of the hydrogen atom and the harmonic oscillator are given. (auth)

60510 NON-RELATIVISTIC LIMIT OF AN AMPLIFIED DIRAC EQUATION. Hanus, W.; Mrugala, R. (Nicholas Copernicus Univ., Torun, Poland). Acta Phys. Pol.; B3: No. 4, 443-9(1972).

An amplified Dirac equation was approximately reduced to the subspace of positive energy states following the "elimination" and "transformation" methods generalized to this case, successively. Their mutual equivalence was verified by explicit calculations accomplished to the third order of approximation. (auth)

60511 ACCELERATED CONVERGENCE OF SEQUENCES OF QUADRATURE APPROXIMANTS. Chisholm, J. S. R. (Kent Univ., Canterbury, Eng.). pp 1.12-1.29 of Advanced Computing Methods in Theoretical Physics. Vol. 1. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655—(Vol.1).

Methods developed for evaluating single-variable finite range integrals of integrands with singular end-points are presented. Three types of quadrature approximations are envisaged: the 2-point Legendre—Gauss quadrature on 2^p equal subintervals, the trapezoidal rule, and the arithmetic Legendre—Gauss quadrature. Three acceleration methods are described: the Romberg method, the Bulirsch—Stoer method, and the Pade method. The results obtained are compared. (France)

60512 CALCULATION OF TRACES OF PRODUCTS OF GAMMA MATRICES. Hearn, A. C. (Univ. of Utah, Salt Lake City). pp 1.30-1.44 of Advanced Computing Methods in Theoretical Physics. Vol. 1. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655—(Vol.1).

The methods available for calculating the trace of a product of Dirac γ matrices are reviewed. The algorithms which have proved to be the most useful for a computer calculation of these traces are discussed, tensor contraction methods being specially emphasized. (France)

60513 COMPUTER SOLUTION OF ALGEBRAIC PROBLEMS BY PATTERN MATCHING. Hearn, A. C. (Univ. of Utah, Salt Lake City). pp 1.45-1.57 of Advanced Computing Methods in Theoretical Physics. Vol. 1. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655—(Vol.1).

The REDUCE system, an algebraic system developed for pattern matching in physical calculations, is presented. The methods used for designing the routines which implement this matching are considered. The system is a list processing system which utilizes LISP as an intermediate language. (France)

60514 CONVERGENCE OF THE PADE APPROXIMANTS IN THE GENERAL CASE. Zinn-Justin, J. (CEN de Saclay, Gif-sur-Yvette, France). pp 2.88-2.102 of Advanced Computing Methods in Theoretical Physics. Vol. 1. Marseille; Centre National de la Recherche Scientifique (1971).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655—(Vol.1).

The convergence of the $[N \pm j, N]$ Pade approximants for functions which are meromorphic over the entire complex plane was recently demonstrated by Nutall. A new derivation of this theorem is presented which yields slightly better results than those obtained by Nutall. The method enables the convergence of Pade approximants in the circle of radius $R/\sqrt{3}$ to be demonstrated for a class of functions meromorphic in the circle of radius R, except for an open zero measure set. (France)

60515 MONTE-CARLO METHOD CALCULATION OF THE GROUND STATE OF AN N BOSON SYSTEM. Levesque, D. Paris Univ., Orsay, France). pp 3.1-3.4 of Advanced Computing Methods in Theoretical Physics. Vol. 2. Marseille; Centre National de la Recherche Scientifique (1971). (In French).

From 2nd conference on advanced computing methods in theoretical physics; Marseille, France (21 Jun 1971). See CONF-710655—(Vol.2).

The Monte Carlo method used to compute the ground state of an n boson system is fundamentally similar to that used to solve the homogeneous and inhomogeneous Fredholm equations. The method is briefly described for the hard sphere case. (France)

REACTOR TECHNOLOGY

Power Reactor Development

Refer also to abstract 58671.

60516 (GULF-GA-A–12150) HTGR BASE PROGRAM QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING MAY 31, 1972. (Gulf General Atomic Co., San Diego, Calif.). 30 Jun 1972. Contract AT(04-3)-167. 126p. Dep. NTIS.

The High-Temperature Gas-Cooled Reactor (HTGR) work reported includes studies of basic fission-product distribution mechanisms, recycle fuel studies (including designing and testing of recycle test elements) and exploration of head-end reprocessing methods (as part of a national recycle plan and of a recycle fuel plant), and physics and fuel management studies. Materials studies include irradiation and analysis of fuel particles in capsules to evaluate fuel systems, and basic studies of control materials and of carbon and graphite. Experimental procedures and results are discussed and, where appropriate, the data are presented. (auth)

60517 (GULF-GA-A–12252) GAS-COOLED FAST BREEDER REACTOR. Quarterly Progress Report for the Period May 1, 1972–July 31, 1972. (Gulf General Atomic Co., San Diego, Calif.). 31 Aug 1972. Contract AT(04-3)-167. 69p. Dep. NTIS.

The tasks of the Gas-Cooled Fast Breeder Reactor (GCFR) program supported by the U. S. Atomic Energy Commission are program planning, core development, fuels and materials development, and nuclear analysis and reactor physics. The status of the development program planning document for the 300-MW(e) GCFR demonstration plant is given. Core development work included studies of the fuel-rod grid support structure, fuel-rod behavior with burnup, control-rod cooling and surface roughening, the grid-plate support structure seal, the pressure-equalization system flow network model, and the thermal shield design. In fuels and materials development, the status of the thermal-flux and fast-flux irradiation programs are given. Post-irradiation examinations of the GB-9 fuel rod irradiated in the ORR and of the G-3 rod irradiated in EBR-II are continuing. Reactor physics studies included calculations of spectral effects on small-sample worths, Doppler worth, and analysis of allowable uncertainties in gas-cooled fast reactors. (22 references) (auth)

60518 (JPRS–57165) SOVIET NUCLEAR REACTORS, FAST NEUTRON REACTORS AND PROSPECTS FOR THE FUTURE. Petros'yants, A. M. Translated from Nov. Zhizni, Nauke, Tekh., Ser. Fiz.; No. 1, 9-19; 22-32(Jan 1972). 22p. NTIS.

The report contains a survey of nuclear reactors now in operation in the USSR and prospects for their development in the future. Schematic diagrams of both working and planned reactors are given. Tables are provided for the main characteristics of reactors including fast-neutron type. (auth)

Physics and Core Engineering

60519 (AEEW-M–1127) ANALYSIS OF SGHW EXPERIMENTS USING REVISED NUCLEAR DATA IN WIMS. Allen, F. R.; Fayers, F. J.; Hammond, A. D. (Atomic Energy Establishment, Winfrith (England)). Aug 1972. 13p. Dep. NTIS (U. S. Sales Only).

The implications for SGHWR calculations of recent changes in basic nuclear cross-sections are examined. The changes proposed by Chawla for use in the WIMS lattice code are evaluated against Winfrith SGHWR lattice experiments with plutonium fueling, as well as later experiments with Natural Uranium fuel in a modified cluster geometry. It is shown that the use of the Chawla data in WIMS in place of previous conventional data gives an improvement in absolute reactivities and reaction rates for the enriched system, and there are also some rather smaller benefits for the Natural Uranium experiments. A tendency to give a too positive void coefficient is slightly improved with the Chawla data, but neither data set exhibits much error in void coefficient when viewed against the Natural Uranium experiments. Results from the Winfrith SGHW power reactor are also considered, and the evidence from reactor measurements of void coefficient, reactivity burnup, and isotopic depletion is evaluated. The general conclusion is made that adoption of the Chawla data in WIMS should give adequate accuracy in prediction of reactivities and void coefficients for SGHWR-type reactors with ^{235}U or Pu-enriched fuel. 10 references. (auth)

60520 (AEEW-R–785(Pt.1)) LWR-WIMS: A MODULAR COMPUTER CODE FOR THE EVALUATION OF LIGHT WATER REACTOR LATTICES. PART 1. DESCRIPTION OF METHODS. Fayers, F. J.; Davison, W.; George, C. H.; Halsall, M. J. (Atomic Energy Establishment, Winfrith (England)). 15 May 1972. 113p. Dep. NTIS (U. S. Sales Only).

LWR-WIMS is a comprehensive "modular" scheme of computation for studying the reactor physics aspects and burnup behavior of typical lattices occurring in modern Light Water Reactor designs. This report describes the basis of all the physics methods which have been incorporated in the code. The basic feature of the scheme is a coupled multi-cell spectrum calculation, which enables reduction of the energy group structure and the smearing of pin-cells containing fuel rods or poison pins. Both diffusion theory and transport theory modules in cartesian geometry are available for determining overall flux distributions in the reduced group structure. Special techniques are used to handle the positional effects of burnup and the buildup of fission product poisons. Some new approximate methods for dealing with highly absorbing regions in the context of diffusion theory, and for homogenizing the interior of the BWR heterogeneous control cruciforms are described. Various numerical studies designed to establish the accuracy of the principal aspects of the computational strategy are also discussed in the appropriate sections. 67 references. (auth)

60521 (AI-AEC–13034) LMFBR PHYSICS PROGRAMS. Annual Technical Progress Report, Government Fiscal Year 1972. (Atomics International, Canoga Park, Calif.). 15 Aug 1972. Contract AT(04-3)-824. 116p. Dep. NTIS.

BORON CARBIDES—reactivity worth in fast reactor control rod mockups, (E/T)
CRITICAL ASSEMBLIES—physics parameters of ZPR-3, ZPR-6, and ZPPR-2 benchmark cores, (E/T)
—cores for FCEL, configuration and reactivity worth measurements in
—neutron spectra in FCEL Cores 20 and 20 N, (E/T)
—neutron fission ratios in FCEL Cores 20 and 20 N, (E/T)
—neutron importance distribution in FCEL Core 20, measurements of axial fission, (E/T)
—control rod mockups in, FCEL Cores 20 and 20 N reactivity worths of boron carbide and tantalum, (E/T)
—neutron flux distributions in FCEL Cores 20 and 20 N, (T)
—Doppler reactivity effect measurements in ZPPR-2, DOPFIT-II code analysis of
LIQUID METAL FAST BREEDER REACTOR—physics measurements for, summary of fiscal year 1972
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NEUTRON CROSS SECTIONS—calculations for fast reactors, evaluation of ENDF/B data for
NEUTRONS, DELAYED—yields from fission of fast reactor fuels, review and evaluation of, (E/T)
PLUTONIUM 239—neutron fission rate in FCEL Core 20 N, effects of axial position on
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REACTORS, FAST—physics parameters of, AIRABL code calculations of
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SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR—physics parameters of benchmark cores in, (E/T)
TANTALUM—neutron cross sections for, AIRABL code calculations of effective
—reactivity worth in fast reactor control rod mockups, (E/T)
—neutron absorption rates in fast reactors, effects of core position on
—gamma ray heating of control rod mockups of, (E)
TUNGSTEN—neutron cross sections for, evaluation of ENDF/B data for, (E/T)
URANIUM-235—neutron fission rate in FCEL Core 20 N, effects of axial position on
URANIUM-238—neutron cross sections for, AIRABL code calculations of effective
—neutron fission rate in FCEL Core 20 N, effects of axial position on
URANIUM-239—neutron cross sections for, AIRABL code calculations of effective
ZEBRA Reactor—physics parameters of benchmark cores in, (E/T) (H.D.R.)

60522 (ANL–7942) CALCULATIONAL ANALYSIS OF TESTS OF EBR-II CAPTURE-TO-FISSION RATIOS. Meneghetti, D.; Rempert, R. H. (Argonne National Lab., Ill.). Jul 1972. Contract W-31-109-Eng-38. 20p. Dep. NTIS.

Values of neutron flux determined by two-dimensional RZ- and XY-geometry calculations using multigroup analyses were used to obtain capture-to-fission ratios of fissile and fertile isotopes at various radial and axial positions in a number of EBR-II core loadings. Details of geometry and loadings are considered, and the calculated ratios are compared with reported ratios obtained by foil irradiations. (auth)

60523 (BNWL–1678) MEASUREMENT OF NEUTRONIC PARAMETERS FOR A PLUTONIUM FUELED HTGR LATTICE. Newman, Darrell F. (Battelle Pacific Northwest Labs., Richland, Wash.). May 1972. Contract AT(45-1)-1830. 73p. Dep. NTIS.

Neutronic parameters were measured in the High Temperature Lattice Test Reactor (HTLTR) for a graphite moderated ThO_2–PuO_2 fueled lattice to serve as a benchmark for evaluating computational methods and cross sections used in the design of a plutonium-fueled High Temperature Gas-Cooled Reactor (HTGR). Measurements made as a function of temperature from 20°C to 1000°C included k_∞, the reactivity perturbations of a number of different fuel and poison samples, and the thorium Doppler coefficient. The calculated and measured changes of k_∞ with temperature are in agreement. An experiment-theory correlation provides a basis for assessing the uncertainties in neutronics calculations. 31 references. (auth)

60524 (EURFNR–993) FAST BREEDER PROJECT. Fourth Quarterly Report, 1971. Hueper, R. (comp.) (Kernforschungszentrum, Karlsruhe (West Germany)). Translation of report KFK–1271/4. 80p. Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Information on the development of liquid sodium cooled fast reactors is presented under the following topics: fuel rod development; material studies and development; corrosion tests and coolant analyses; physics experiments; reactor theory; safety aspects of fast reactors; core instrumentation and signal processing for core monitoring; effects of reactor incidents on the environment; sodium technology experiments; design studies on sodium cooled fast reactors; and FR-3 Reactor. (D.C.C.)

60525 (EURFNR–1015) FAST REACTOR PROGRAMME. First Quarter 1972 Progress Report. Hoekstra, E. K. (comp.) (Reactor Centrum Nederland, Petten). May 1972. 82p. (RCN–171). Dep. NTIS (U. S. Sales Only).

Work performed under United States–Euratom Fast Reactor Exchange Program.

Information on the RCN fast reactor program includes: reactor physics, fuel irradiations, advanced fuels, radiation damage in canning materials, analysis of impurities in sodium, aerosol research and heat transfer and hydraulics. (22 references) (auth)

60526 (GEAP–13838) EXPERIMENTAL PROGRAM RESULTS IN SEFOR CORE II. Noble, L. D.; Kussmaul, G.; Derby, S. L. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Jun 1972. Contract AT(04-3)-540. 233p. Dep. NTIS.

The results of zero power experiments, static and oscillator tests at power levels up to 20 MW where the peak fuel temperatures approach melting, and transient tests involving rapid ejection of up to 1.2 dollars in the second core (Core II) test program are reported and compared with calculations. The experimental results are in agreement with calculations, and the experimental value of -0.0060 ± 0.0006 for the Core II Doppler T dk/dT compares favorably with the calculated value of -0.0063. The superprompt critical transients resulted in peak power levels of 10,000 MW, and they clearly demonstrated the inherent prompt shutdown mechanism of the fuel Doppler coefficient. 55 references. (auth)

60527 (JAPFNR–41) PLAN OF EXPERIMENTAL STUDY OF COOLANT MIXING EFFECT IN JAPAN EXPERIMENTAL FAST REACTOR "JOYO" SUBASSEMBLY. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Translated from a Japanese report. (PNC-N–141-72-1-11). 11p. Dep. NTIS (U. S. Sales Only).

The coolant mixing effects in the core and blanket subassemblies of the Japan Experimental Fast Reactor, "JOYO" will be experimentally investigated using full size mockups in a sodium loop. The mockup consists of electrically heated pins, thermocouple installed pins and dummy pins. The mixing rates are obtained by measuring the temperature distributions in sodium and/or heater pin surfaces. In the core mockup subassembly, coolant temperature distributions are measured, that is, macroscopic mixing effects will be studied. In the blanket mockup, however, not only coolant but also heater pin surface temperature distributions are measured, so that some information about microscopic mixing effects such as hot spot temperature of fuel cladding is obtained. (auth)

60528 (JUL–850-RG) SPATIAL XENON OSCILLATIONS IN HIGH-TEMPERATURE REACTORS. Lauer, Achim (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). May 1972. 313p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

For the optimum control of xenon-induced spatial power density oscillations in large thermal nuclear reactors, one requires detailed calculations of the space-time core behavior. An extensive, modular program system (ASTERIX) has been developed which permits computation of xenon transients and their control with exact representation of the complex core layout. The mathematical procedure is characterized by the following key words: quasi-stationary multi-group diffusion theory by the difference method; one or two space-dimensions (xy, rz, and $r\varphi$ geometry); variable discretizations: any number of energy groups, space mesh-points and material regions; different criticality searches; internal regions with boundary conditions; associated spectral programs; a pointwise xenon-feedback; time-extrapolation of fluxes in the time-steps. The different functions are integrated in a complex program system, flexible to use, which in its nuclear part is not bound to a special reactor type. A temperature feedback may be combined in a modular manner. An extensive graphic transient display system with a special data bank and multiple access methods enables in combination with a data plotter separated from the computation, the flexible optic analysis of all cases. The program cycle permits individual simulations of xenon transients with different ways of excitation and control measures. A long-term and systematic study is described on possible xenon-instabilities in high-temperature reactors (HTR). The different oscillation modes in axial, radial, and azimuthal direction were studied by the aid of ASTERIX in more than 100 cases. A general survey is given on oscillation forms, stability characteristics and their dependence from different core parameters; the essential physical processes at excitation, process, and control of the oscillations are discussed by near 300 selected computer drafts. Also, special effects are discussed, e.g., operator-induced instabilities, oscillations of unsymmetric cores, limit amplitudes in the non-linear region, and the precession of azimuthal oscillations. Numeric questions referring length of time-steps and criterium of flux-convergence are studied, one- and two-dimensional computations are compared. (82 references) (auth)

60529 (RISO-M–1497) LECTURES ON REACTOR DIVISION WORK PRESENTED AT INFORMATION MEETING, APRIL 20, 1972. (Danish Atomic Energy Commission, Risoe. Research Establishment). 1 May 1972. 173p. (In Danish). Dep. NTIS (U. S. Sales Only).

The purpose of the lectures given at the Information Meeting of the Reactor Physics Section was to describe briefly the achievements of the past year. As the presentations were extemporaneous, it was found desirable to make the content available in a report circulated outside of the Research Establishment. C. F. Hojerup reported on the current situation of the reactor physics research; H. Neltrup and C. F. Hojerup reviewed data generation and burnup calculations concerning fuel pins and assemblies; Hans Larsen reported on effect dependent coupling; B. Micheelsen talked on fuel management; safety evaluation problems as related to reactor physics were examined by P. B. Suhr within the framework of the PWR study project. The activities of the Dr-1 Group and burnup measurements were reported by J. Olsen. The Heat Technology and reactor dynamics questions were first outlined by A. Olsen while Z. Rouhanl (A. B. Atomenergi) discussed the stationary problems within the framework of the Scandinavian cooperative project and P. Skjerk Christensen reactor transients, including the Scandinavian reactor dynamics project and the hybrid PWR model. The emergency operations were reported by J. Andersen while V. Pejtersen reported on the Marvinen safety engineering experiment. The meeting also included a presentation by the computer group by L. Hansson and O. Lang Rasmussen. (TTT)

60530 DESIGN AND ASSESSMENT STUDIES PERFORMED BY THE GBR ASSOCIATION ON GAS COOLED FAST REACTORS. Gratton, C. P. (Atomic Energy Establishment, Winfrith, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 4, 331-6(Oct 1972).

The design and assessment work performed on gas cooled fast reactors by several European industrial companies and research organizations is summarized. A description is given of the programme and its background, together with the technical features of the reference designs studied. In conclusion there is a summary of the performance obtained and the future work planned. (auth)

60531 SPACE–ENERGY FLUX SYNTHESIS IN FAST REACTORS. Sipush, Paul Joseph. Pittsburgh; Carnegie-Mellon Univ. (1972). 112p. University Microfilms Order No. 72-21,605.

Thesis.

The use of space energy synthesis for fast reactor calculations is investigated with emphasis placed on analysis of anomalies to which the method is susceptible. Different types of anomalies were in evidence and found to be related to the form of the weighting functions. The numerical solution of the synthesis equations was analyzed by investigating the matrix form of the equations which results from discretizing the spacial mesh. The eigenvalue spectrum and higher harmonics were evaluated and it was determined that convergence problems for anomalous cases when employing the power method are related to dominant complex eigenvalues in the spectrum and high dominance ratios. Different forms of weighting functions are thoroughly investigated from the standpoint of the quality of solution and the avoidance of anomalies. A simple method of improving trial functions is presented which is based on a preliminary synthesis solution employing poorer trial functions. Calculations, including control rod worths, in a multizone core model are made and compared to few-group diffusion theory results. Also a fine-energy-detail problem is solved with synthesis using a simple two region slab model with an iron reflector in which the scattering resonances are represented explicitly. The applicability of space-energy synthesis to this and other problems is discussed. (Diss. Abstr. Int., B)

60532 HYBRID SOLUTION OF THE TIME–SPACE–ENERGY DEPENDENT NUCLEAR REACTOR EQUATIONS. Schultz, K. R.; Bullock, T. E.; Ohanian, M. J. (Univ. of Florida, Gainesville). pp 471-8 of Conference on Hybrid Computation. Brussels; Presses Academiques Europeenes (1970).

From sixth conference on hybrid computation; Munich, Germany (31 Aug 1970). See CONF-700826.

A method for direct numerical solution of the time, space and energy dependent neutron diffusion equation that utilizes the hybrid computer is presented. The hybrid method uses an iterative discrete space, continuous time algorithm. The space derivatives of the conventional multi-group reactor kinetics equations are represented by finite difference approximations. The resulting very large set of coupled ordinary differential equations in time can be solved quite readily on the hybrid computer by multiplexing the analog hardware and using an iterative procedure. The flux and precursor equations at one space point are set up on the analog computer. The digital computer supplies the space coupling terms from adjacent space points; it also observes and stores the solutions for later playback. Hybrid solutions to typical one- and two-group spatial kinetics examples are presented. 13 references. (auth)

Control and Instrumentation

60533 CONFERENCE ON HYBRID COMPUTATION. Proceedings of the Sixth International Analogue Computation Meetings, Munich, Germany, August 31–September 4, 1970. Brussels; Presses Academiques Europeennes (1970). 841p. $40.00. (In several languages). (CONF-700826).

Papers from a conference on the applications and programming of hybrid computers are presented. Separate abstracts were prepared for seven papers which were within the subject scope of NSA; four papers had been abstracted previously. (J.M.J.)

For abstracts of individual papers see: 58676, 60532, 60537, 60595, 60598, 60599, and 60751.

Coolant System

Refer also to abstract 59261.

60534 (ANL–7944) SODIUM TECHNOLOGY QUARTERLY REPORT, JANUARY–MARCH 1972. Kesser, G. M. (comp. and ed.) (Argonne National Lab., Ill.). Aug 1972. Contract W-31-109-Eng-38. 60p. Dep. NTIS.

The research, development, and management efforts of Argonne National Laboratory's Sodium Technology Program for the period January–March 1972 comprised activities in the following areas: (1) In the national meter program, performance-characterization tests of an improved electrochemical oxygen meter have continued, with emphasis on meter calibration by the vanadium-wire equilibration method for determining oxygen activity; other work has included testing of on-line monitors for hydrogen and leak detectors for steam generators, development of a method for relating the outputs of carbon meters to the carbon activity of sodium, and testing of modules for these meters. (2) In the analytical standards program, efforts continued on the preparation of RDT standards relating to specifications for measuring and controlling the purity of sodium and cover gas; laboratory work included characterization of particulates filtered from various sodium systems and development of methods for determining oxygen activity in sodium by the equilibration of niobium wires and for determining hydrogen activity in sodium by the equilibration of vanadium and niobium. (3) Design work was started on a cover-gas analysis system for separating ^{23}Ne from noble-gas fission products in cover gas, fabrication was started on a laboratory prototype of a system for monitoring the ^{135}I content of reactor primary sodium, and development work continued on an on-line diffusion meter for monitoring tritium in sodium. (4) Studies of the chemistry of liquid sodium have been directed toward investigations of oxygen–hydrogen interactions in sodium using deuterium as a stand-in for hydrogen, and construction of an apparatus for determining the effects of oxygen–hydrogen interactions on oxygen and hydrogen meters. (5) Work has continued on the program to determine the integrated effects of fast-neutron and sodium environments on the properties of stainless steel, to develop postexposure testing methods for the stainless steel specimens, and to correlate the results from experimental and reactor sodium systems; in the study of carbon transport in sodium–steel systems, additional data have been obtained on carbon activities in Fe–Ni and Fe–Ni–Cr alloys. (auth)

60535 (FRNC-CONF–43) METHOD FOR STUDYING PROBLEMS RELATED TO LIQUID SODIUM FLOWS. Constantin, J. P.; Huffenus, J. P.; Lambert, P.; Leon, P. (Societe Grenobloise d'Etude et d'Applications Hydrauliques (France)). 1972. 6p. (In French). (CONF-720648–5). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

The methods used to study liquid metal circulation problems in sodium cooled reactors are described. The following points are emphasized: isothermal pressure and free-surface flow (head losses, cavitation, surface roughness, gas entrainment); vibration of immersed shells and structures; non-isothermal flow (heat transfer, natural and mixed convection). (8 references) (auth)

60536 CHALLENGES IN DEVELOPMENT OF MATERIALS FOR FAST REACTORS: CAN WE REALLY DO BETTER? Karsten, G. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). pp 75-88 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971)

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

The analysis of completed experiments and those that are under evaluation within the program for the sodium-cooled fast reactor, SNR (Schneller Natriumgekühlter Reaktor), are discussed. The planning philosophy for test reactors receives special consideration. The description and status of the present program, as well as the characterization of experimental programs for the future, including the development of sodium, helium, and steam coolants, are discussed. Considerations of economics are emphasized throughout. (auth)

60537 WATER-HAMMER IN A CLOSED CIRCUIT ANALYSIS WITH A HYBRID COMPUTER. De Hes, M. (N. V. Neratoom, The Hague). pp 488-95 of Conference on Hybrid Computation. Brussels; Presses Academiques Europeenes (1970).

From sixth conference on hybrid computation; Munich, Germany (31 Aug 1970). See CONF-700826.

A review is given of a hybrid computer study for investigating the safe valve closure time of the quick-acting stop valves in the secondary sodium circuit of a fast breeder reactor. The partial differential equations describing water-hammer in a pipeline are approximated with a "Discrete Space Continuous Time (DSCT)" method in a system of first order differential equations. To solve these equations and the matching boundary conditions, an AD 4–IBM 1800 hybrid computer was used. The results of the calculations are given. 7 references. (auth)

Fuels and Fuel Elements

Refer also to abstract 59183.

60538 (ANL–7912) PERFORMANCE IN THE EBR-II OF A MIXED-OXIDE FUEL ELEMENT WITH AN INTENTIONAL CLADDING DEFECT. Koenig, J. F. (Argonne National Lab., Ill.). Jul 1972. Contract W-31-109-eng-38. 30p. Dep. NTIS.

A technique involving dissolution of a soluble material in the cladding of an element was used to obtain a fission-gas release from a low-burnup (~1 at. %) mixed-oxide fuel element to the primary-system cover gas in EBR-II. The release of short-half-life fission gas was a small fraction (<0.6%) of the total inventory in the element, the ^{133}Xe release being double the release of the shorter-half-life ^{135}Xe. No plutonium was detected in the primary coolant after the event, nor was difficulty encountered in the hot cell during disassembly or handling of the element. The gas from this element was identified by the xenon tag initially charged in the element plenum. The satisfactory identification of the source of the gas demonstrates the suitability of this technique for low-burnup elements. (7 references) (auth)

60539 (EUR–4862) TRANSIENT HEAT CONDUCTION THROUGH A CYLINDRICAL THREE-LAYER HOLLOW FUEL ELEMENT WITH INTERNAL AND EXTERNAL COOLING. Wundt, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug 1972. 46p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 60.-.

The method of solving Fourier's equation for locally selected temperatures by Laplace transform techniques is extended and applied to the case of a three layer hollow cylinder. The middle, heat-generating cylinder is canned internally and externally by non-producing layers respectively, before the heat is carried away by convection, on both sides. The effect of small gaps between the layers is considered. Both coolant bulk temperatures as well as the heat source density are arbitrary input functions of the time. They may also be the outputs of some other program (neutron kinetics equations, e.g.) so that the systems may be treated simultaneously. The time behavior of the interesting temperatures is presented explicitly; only some auxiliary functions must be generated by integration of very simple ordinary differential equations. In this sense, the solution is not yet "complete," but prepared for a digital programmation, which will certainly be much time-saving against conventional integration methods. (auth)

60540 (JUL–858-RG) BASIC STUDY FOR THE PEBBLE-BED REACTOR WITH THE OTTO LOADING SCHEME. Teuchert, Eberhard; Maly, Vladimir; Haas, Klaus-Arne (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). May 1972. 78p. (In German). Dep. NTIS (U. S. Sales Only).

In the Once Through Then Out (OTTO) loading scheme of the pebble-bed reactor, the fuel elements pass very slowly through the core for only one time, and the coolant-gas flows in parallel direction. In the lower hot region, the pebbles are depleted and therefore have a reduced power output. The temperature gradient is remarkably low; this enables heating the gas to considerably higher temperatures than in the conventional high-temperature reactor. By using this reactor in a steam-cycle system with an average gas outlet-temperature of 750°C, the fuel temperature in the center of the hottest balls remains below 870°C. For the generation of process heat it is possible to achieve an average gas outlet-temperature of 950°C under an average power density of 8.7 MW/m^3. The possibility of achieving particularly high gas-temperatures is of decisive advantage for the application as a helium-turbine power plant. A wide survey study for the fuel cycle with low enriched uranium is presented and an optimized lay-out is deduced. The physical properties of this reference design are discussed in detail, and the computations for some alternatives show the influence of variations in lay-out and operation scheme. Moreover, they bring the characteristic data of this reactor under the conditions of a process-heat system, of a gas-turbine cycle, and of the conventional steam cycle. As a consequence of the simplified loading scheme, no equipment for reloading and burn-up measurement is necessary. The considered fuel element is the conventional fuel ball which is well tested with regard to production techniques, temperature load, irradiation, and burn-up. Therefore, no expensive and time-consuming development work is necessary for this reactor type. 17 references. (auth)

60541 (KFK–1603) FAST BREEDER PROJECT STATUS REPORT, 1972. (Kernforschungszentrum, Karlsruhe (West Germany)). May 1972. 130p. (In German and English). (EUR–4843). Dep. NTIS (U. S. Sales Only).

Lectures given at the Fast Breeder Project Status Report meeting at Mol (Belgium) on March 23, 1972 are presented. Part of the lectures present long-term perspectives of fast breeder development from the viewpoint of nuclear power station producers, utilities, and scientific research, other lectures give summaries of work done in the research centers in the framework of the Fast Breeder Project Base Program and the R&D related to SNR construction, special lectures concentrate on fuel rod development and reactor safety. The report is concluded by the press release of Schnell – Brüter – Kernkraftwerksgesellschaft on the letter of intent concerning SNR 300 construction. (auth)

60542 (TID–26143) DEVELOPMENT OF CYGRO-F FOR FUEL ROD BEHAVIOR ANALYSIS. Harbourne, B. L.; Beck, M. S.; Foster, J. P.; Biancheria, A. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). 1971. Contract AT(11-1)-3045. 56p. Dep. NTIS.

An LMFBR fuel rod performance analysis system was developed using the CYGRO-F computer code. The approach used was to model materials properties and phenomena using basic data and fundamental formulations as far as possible. Lack of data and understanding prevent a completely fundamental solution. The uncertainties were resolved by proof testing the code against selected experimental results and making appropriate adjustments to the models. The result is an analytical system of models integrated into a central stress-strain analysis. Application of the system to independent experimental data gave satisfactory agreement between analysis and observation. Examples of the application of the code to LMFBR fuel rod performance analysis are presented. Four highly significant models emerged. The analytical fuel swelling model simulates volume increase saturation and the subsequent volume conservate growth mechanism which can result in center hole growth independent of pore migration. This model describes the nucleation, growth and migration of gas bubbles and produces mechanical effects similar to those in the analytical model. The cladding swelling model accounts for the effects of stress on swelling rate to reproduce the large volume changes observed in some fuel rod claddings. Studies of startup and early life behavior resulted in a thermo-mechanical analysis system which describes in detail the complex interacting phenomena occurring under these transient conditions. The system may be applied to the determination of LMFBR core limiting operating conditions. (29 references) (auth)

60543 POST-SHUTDOWN HEAT RELEASE IN THE REACTOR FUEL. Unger, H. (Univ., Stuttgart). Atomkernenergie; 19: No. 4, 283-90(Jul 1972). (In German).

Contributions of various decay mechanisms to the post-shutdown decay heat are analyzed by means of a specific example. It is shown that approximately from 3 min. to 2 days after shutdown the heat is produced essentially by ^{239}U, ^{239}Np, and the fission products. The fractional distribution of the fission products and their contribution to the decay heat is calculated. The chemical and physical behavior of the fission products in the fuel is discussed. The contribution of different chemical elements and groups to the total heat production is calculated. The fraction of different elements which remain in the fuel under various conditions and temperatures is investigated as well as the amount of the heat released in the fuel. This investigation was conducted especially with respect to melting- and boiling fuel with results indicating that approximately 50% of the heat sources remain in the fuel at its boiling temperature and between 60% to 80% at lower temperatures. (auth)

60544 FAST REACTOR FUEL ELEMENT TECHNOLOGY. Proceedings of the Conference Held at New Orleans, Louisiana, April 13–15, 1971. Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971). 929p. (CONF-710414).

Thirty-three of the 45 papers presented are abstracted separately. The other 12 papers have been abstracted in NSA previously. (J.M.J.)

For abstracts of individual papers see: 60536, and 60545–60576.

60545 LMFBR FUEL DESIGN: WHY CAN'T WE DO BETTER? Kintner, E. E. (Atomic Energy Commission, Washington, D. C.). pp 1-18 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

In the development of the ability to design fast reactor fuel elements we seem to have passed into increasingly difficult problems. Each of these problem areas was dominant in design philosophy at one point. They are understanding and allowing for fission gas pressure, fuel swelling, stainless steel swelling, and the effects of irradiation on mechanical properties, most recently irradiation-enhanced creep. None of these problems has yet been completely surmounted. How many more lie ahead is unknown. This discussion centers on the deficiencies in our process of designing and developing LMFBR fuel elements. (auth)

60546 FUEL ROD DESIGN BASES. Anderson, C. A. Jr.; Markley, R. A.; Patterson, J. F. (Westinghouse Electric Corp., Madison, Pa.). Contract AT(30-1)-4200. pp 59-74 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Statistical techniques which may be used to account for all uncertainties and eventually provide valuable insight in establishment of realistic design limits are described. A philosophy to arrive at both steady state and transient design limits is discussed. (auth)

60547 CONSIDERATION OF STABILIZED STAINLESS-STEEL ALLOYS FOR LMFBR FUEL CLADDING. Spalaris, C. N.; Zebroski, E. L. (General Electric Co., Sunnyvale, Calif.). pp 89-100 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Recent data show severe losses of carbon, nitrogen, and boron from Types 316 and 304 stainless steel when exposed to flowing sodium. Such losses result in degradation of mechanical properties which can limit the desired fuel lifetimes of unstabilized steel grades if used in fuel-cladding applications for LMFBR cores. Most data to date on mechanical properties for cladding materials exposed to neutron flux do not include the combined effects of temperature, flowing sodium, and radiation. A few fuel-cladding specimens that include the combined effects will be available for testing during the latter part of 1973. Carbon transport from LMFBR cores to the intermediate heat exchanger potentially affects its mechanical properties and service performance. Concern for minor element transport in sodium has stimulated active consideration of stabilized stainless grades as fuel-element-cladding applications above 1200°F. 9 references. (auth)

60548 HELICAL WIRE SPACER MODEL IN LARGE-BUNDLE THERMAL HYDRAULICS. Kolesar, Donald C. (WADCO Corp., Richland, Wash.). pp 101-11 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Extensions of the COBRA heat transfer codes to large sodium-cooled fuel pin bundles and coolant mixing effects due to the presence of helical wire spacers are described. Bundle sizes up to 217 pins are considered. Flow revolution, induced by the helical path of the wires through the fuel pin bundle, is mathematically modeled. Only a few input parameters are required to characterize the complete set of interchannel mixing rates. A net circumferential movement of the fluid along the duct (fuel pin container) wall synchronous with the helical wire path is predicted by the models. Limitations on the code parameters due to the simulation of a boundary-value problem with an initial-value problem are discussed. Comparisons of the new COBRA results with experimental data have been successful where attempted. 13 references. (auth)

60549 ANALYSIS OF BOWING AND INTERACTION OF LMFBR FUEL SUBASSEMBLIES. Burchill, William E. (Combustion Engineering, Windsor, Conn.). pp 113-34 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

A simple analytical model has been developed for prediction of bowing and interaction of shrouds of fast reactor fuel subassemblies. The model demonstrates the effects of geometry, means of restraint, environmental conditions, and material behavior; i.e., thermal expansion, swelling, and creep. Using the model, the influence of controllable parameters on deflections, restraint forces, and axial stress can be studied. To predict the interaction of shrouds in a reactor core, the core is treated as a single row of shrouds, each modeled analytically. The method of solution is expected to result in considerable savings of computing time compared to other methods currently available. 16 references. (auth)

60550 IMPORTANT MECHANISMS IN THE EXPLANATION OF CLADDING DIAMETRAL INCREASES IN MIXED-OXIDE FUEL PINS. Oldberg, S. Jr.; Hines, D. P. (General Electric Co., Sunnyvale, Calif.). pp 137-56 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Consideration of the mechanics of fuel-cladding interaction in mixed-oxide fuel pins indicates little mechanical effect of the fuel on its cladding under steady-state conditions where voidage exists at the center of high linear power fuel. In low linear power fuel, uncertainties in material properties render the effects of swelling fuel on its cladding unpredictable. Calculations of resistance to axial flow indicate the ability of fuel to flow over considerable distances under moderate axial pressure gradients given high center temperatures and long periods of time. Thus it is important to integrate local effects over the entire length of the fuel pin. Non-steady-state mechanisms, such as power cycling or power increases, have resulted in the cladding deforming at the expense of the fuel expansion, in some cases due to the superior short-term strength properties. Application of the BEHAVE-I code to prediction of diameter increase for 26 mixed-oxide pins yields good agreement with data to burnups of 7 at. %. Greater than predicted diameter increases are found in higher burnup pins. (auth)

60551 MIXED-OXIDE FUEL PIN PERFORMANCE ANALYSIS USING THE OLYMPUS COMPUTER CODE. Boltax, A.; Biancheria, A.; Harbourne, B. L.; Soffa, T. P. (Westinghouse Electric Corp., Madison, Pa.). Contract AT(30-1)-4120. pp 157-99 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

The OLYMPUS-II computer code, developed for the analysis of the irradiation performance of fast reactor mixed-oxide fuel pins, is described. The separate modules of the code are discussed, including stainless-steel swelling, irradiation creep and irradiation hardening, and fuel swelling and plasticity. The OLYMPUS-II code was normalized using data from selected high burnup EBR-II fuel pins. Predictions from the code are compared with measurements on additional high burnup fuel pins with variations in cladding type and fuel smear density. The generally good agreement between the measurements and code predictions provides the basis for application of the code to LMFBR fuel operating parameters. The studies performed with the OLYMPUS-II code reveal the major effects of fuel smear density, fluence-to-burnup ratio, and cladding temperature on the behavior of fuel pins as a function of burnup. 20 references. (auth)

60552 FINE TUNING AN FBR FUEL MODELING CODE. Nathan, Milton E.; Schweinberg, Richard N. (Atomics International, Canoga Park, Calif.). pp 201-9 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

The PROFIT code is used to predict both the thermal and mechanical performance of fast reactor fuel rods as a function of burnup. Fuel is modeled by means of three temperature-density rings; i.e., as-fabricated fuel, equiaxed, and columnar grain regions. The cladding mechanical behavior is predicted from computation of clad swelling, irradiation-enhanced creep, thermal creep, and both internal and external time-dependent clad wastage. To compute the consumed life of the cladding, AI has adopted a life fraction approach in preference to selecting a thermal creep ductility limit. A technique used to "fine tune" the PROFIT predictions of equiaxed grain, columnar grain, and void diameters for GE rods F2H, F2Z, F1A, and F1B, all of which were irradiated in EBR-II is described. The best match between post-irradiation measurements and PROFIT predictions was obtained for equiaxed and columnar grain densities of 97 and 99% TD, respectively, and for equiaxed and columnar grain formation temperatures of 1500 and 1950°C, respectively. Also included is total fission gas release correlation, which for F2H and F2Z gave release fractions of 0.4 for the as-fabricated zone, 0.7 for the equiaxed zone, and 0.995 for the columnar zone. (auth)

60553 SATURN CODES AND MATERIAL DATA EVALUATION. Kummerer, K.; Depisch, F.; Elbel, H.; Kaempf, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 211-25 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

The fuel pin modeling activities in the course of the fast breeder development at the Karlsruhe Research Center are described. The objective of the various versions of the SATURN codes is to treat quantitatively the mechanical and thermal behavior of fuel pins as a function of operation time including steady-state and transient conditions. A first approach of these theoretical studies was SATURN O which was based mainly on a volume balance calculation leading to an assessment concerning maximum burnup. The new pin code SATURN 1 includes all the details of thermal and mechanical phenomena for the fuel, the cladding, and the fuel-cladding interaction. Main points are the treatment of crack formation in the fuel and the contact pressure between the fuel and cladding. The SATURN 1 code is now being used to explain and understand experimental pin behavior as well as to predict the performance of fuel pins. The first applications reported here refer to the explanation of fuel pin behavior in a SEFOR experiment and to calculations for typical fast reactor pin parameter constellations. Finally, an evaluation of material input data indicates the status of necessary and available information for fuel pin modeling work. (auth)

60554 ANALYSIS OF MIXED-OXIDE FUEL ELEMENT IRRADIATIONS USING THE LIFE-I COMPUTER CODE. **Weeks, R. W.; Jankus, V. Z.; Katsuragawa, M.; Lambert, J. D. B.** (Argonne National Lab., Ill.). pp 227-42 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

The LIFE-I fuel element modeling code is based on mathematical representations of fuel and cladding behavior. Since not all the materials properties are known, however, calibration of the code is necessary. The calibration procedures are described, and the differences between LIFE-I predictions when following the full time-varying irradiation history for an element and predictions obtained using "equivalent" steady-state operating histories are discussed. Steady-state LIFE-I predictions for ANL element SOPC-5 and NUMEC elements C-11 and C-15 are shown to underpredict the experimental results due to neglect of both cyclic effects and fuel cracking. It is concluded that an explicit treatment of fuel cracking must be incorporated for a fully realistic treatment of fuel-element behavior. 13 references. (auth)

60555 SWELLING AND GAS-RELEASE MODELS FOR OXIDE FUEL RODS (LWBR DEVELOPMENT PROGRAM). **Nichols, F. A.; Warner, H. R.** (Westinghouse Electric Corp., West Mifflin, Pa.). Contract AT(11-1)-Gen-14. pp 267-89 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Major disagreements exist concerning the dominant mechanisms for the release of fission gases from operating ceramic fuel elements. The multiplicity of phenomena occurring simultaneously, coupled with a dearth of gas-release data with accurate knowledge of the time-temperature history of the elements, makes the task of defining quantitatively the relative importance of specific mechanisms extremely difficult. Except for low temperatures, where relatively small amounts of gas are released, probably by recoil and knockout mechanisms, there are two principal schools of thought on operative mechanisms: the "bubble migration" concept and the "bubble re-solution" concept. Pertinent theory and data are critically reviewed and shown to indicate a strong importance of bubble migration at the higher temperatures ($\gtrsim$1200°C in UO_2), with re-solution effects becoming relatively more important at lower temperatures. A comprehensive model for fission gas swelling and gas-release covering the full temperature range and believed to be reasonably consistent with available data is available in the BUBL computer program. Recent modifications to this program are discussed along with comparisons with available data. 32 references. (auth)

60556 FUEL SWELLING: FAST REACTOR MIXED-OXIDE FUELS. **Duncan, R. N.; Cantley, D. A.; Perry, K. J.; Nelson, R. C.** (General Electric Co., Sunnyvale, Calif.). Contract AT(04-3)-189. pp 291-309 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Experimental measurements of fuel volume changes after irradiation are given for several groups of mixed-oxide fuel rods. Techniques used to measure postirradiation fuel dimensions included: gamma-scan data, photographs of cross sections, and enhanced neutron radiography. The results indicate that fuel swelling in specimens irradiated under typical fast reactor conditions is lower than would be expected for other reactors where the average temperature and temperature gradients are significantly lower. Fuel swelling for typical fast reactor mixed-oxide fuels can be accommodated by use of fuel of a suitable density without gross distortion of the cladding to burnups in excess of 1000,000 MWd/MT. In addition, migration of nongaseous fission products out of the fuel volume has been observed. Noble metals, Mo, Ru, Rh, Tc, Pd, and other fission products, Ba, Zr, and Sr, migrate out of the fuel volume and thereby reduce the magnitude of the fuel swelling attributed to solid fission products. Fuel volume measurements can be made with reasonable accuracy and can add significantly to the understanding of the accommodation of fission products by initial porosity within the fuel. 7 references. (auth)

60557 ADVANCED GAS RELEASE AND SWELLING SUBROUTINE. **Poeppel, R. B.** (Argonne National Lab., Ill.). pp 311-26 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

The general approach necessary for the development of a model that analyzes fission gas behavior is discussed. Models that have appeared in the literature are compared with this approach, and an assessment is made of their predictive capability. Included in the comparison is a model being developed at Argonne. A mechanism that is important in most of the models (mobility of fission gas bubbles) is reviewed. Results from an accident analysis are presented. 27 references. (auth)

60558 RELATIONSHIP OF MECHANICAL PROPERTIES TO THE SWELLING OF OXIDE FUELS AT HIGH TEMPERATURES. **Chubb, W.; Hilbert, R. F.; Storhok, V. W.; Keller, D. L.** (Battelle Memorial Inst., Columbus, Ohio). Contract W-7405-eng-92. pp 327-44 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Data on the external swelling rates, gas release behavior, and microstructural appearance of oxide fuels irradiated in W-25 Re claddings at surface temperatures from 1260 to 1900°C are discussed in relation to the creep strengths of stainless steel, UO_2, and W-25 Re alloy and in relation to data on diffusion rates in iron, UO_2, and tungsten. With the aid of creep strength data on stainless steel and W-25 Re alloy, the external swelling rates of oxide fuels in W-Re at 1260 to 1900°C are transposed into external swelling rates of oxide fuels in stainless steel at 700 to 1000°C. Comparison with data from the literature on the external swelling rates of oxide fuels in stainless steel at temperatures up to 700°C indicates that the transposition is justified. It is concluded that the external swelling behavior of nuclear fuels is dependent upon and can be correlated with the basic cohesive-diffusive nature of the fuel and its cladding. It is also concluded that these same cohesive-diffusive factors require that growth of fission gas bubbles precede gas release from nuclear fuels. 9 references. (auth)

60559 THERMAL PERFORMANCE OF FUEL RODS AND THE PERFORMANCE OF LMFBRs. **Sayles, C. W.; Nathan, M. E.** (Atomics International, Canoga Park, Calif.). pp 383-92 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

The overall performance requirements of LMFBR plants impose performance requirements on the fuel rods. These fuel rod performance requirements, together with fuel behavior mechanisms and fuel physical properties, set the design of the fuel rods. Based on typical LMFBR performance requirements, the fuel rod performance requirements necessary to avoid center fuel melting are derived. Improvement in fuel rod performance will be obtained by improved understanding of fuel physical property (reduction of uncertainties), fuel behavior mechanisms (relaxation of criteria), and from improvement in LMFBR plant design based on experience gained in demonstration plant operation. It is shown that the greatest improvements can come from relaxation of criteria and LMFBR plant design improvements. 9 references. (auth)

60560 FUEL-CLADDING CHEMICAL INTERACTIONS IN UO_2—20 WT PERCENT PuO_2 FAST REACTOR FUEL CLAD WITH STAINLESS STEEL. **Johnson, C. E.; Johnson, I.; Crouthamel, C. E.** (Argonne National Lab., Ill.). pp 393-410 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Irradiated stainless-steel cladding from mixed $UO_2 - PuO_2$ fuel has been shown to be subject to an intergranular attack. The appearance of the attack has been erratic due to fluctuations in the two principal controlling parameters—the oxygen potential and the temperature at the fuel-cladding interface. The most likely mechanism for attack of the cladding appears to be an accelerated oxidation at the grain boundaries. 23 references. (auth)

60561 FUEL-CLADDING REACTIONS OBSERVED IN STAINLESS-STEEL-CLAD MIXED-OXIDE FUEL PIN IRRADIATIONS. **Perry, K. J.; Melde, G. F.; McCarthy, W. H.; Duncan, R. N.** (General Electric Co., Sunnyvale, Calif.). Contract AT(04-3)-189. pp 411-29 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Reaction between fuel and cladding has been found during post-irradiation examinations of mixed-oxide fuel pins. Some of the more prominent observations are described. These results indicate that an accurate understanding of the mechanisms associated with these reactions is needed for advanced LMFBRs. Too few well characterized tests have yet been performed to allow the generation of any firm theory governing the responsible corrosion mechanism(s). Two facts stand out, however: Fission products are responsible for the corrosion. Out-of-pile tests have not shown extensive corrosion below 1400°F between mixed oxides and austenitic stainless steels in the absence of fission product constituents. Temperature has a predominant influence on the corrosion behavior. While thermal and fast flux test results do not always agree as to the rate of corrosion for a given material and temperature combination, they are internally consistent in that high temperature produces more extensive reaction. (auth)

60562 REACTIONS OF SODIUM WITH MIXED-OXIDE FUELS. **Aitken, E. A.** **(General Electric Co., Pleasanton, Calif.); Evans, S. K.; Melde, G. F.; Rubin, B. F. Contract AT(04-3)-189. pp 459-78 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).**

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

The principal manifestation of a reaction of sodium with the mixed oxide is the tendency to cause swelling in failed fuel pins which in time changes the coolant flow and temperature patterns near the affected pins. The thermodynamic and kinetic bases of the reaction mechanism from available experimental information are discussed. The rate and degree of swelling have been correlated with the oxygen available for reaction with the sodium. The basic reaction may be described as follows: $MO_{2-x} + [3(y-x)/2 + y]Na \rightleftharpoons (y - x/2 + y)Na_3MO_4 + (2 + x/2 + y)MO_{2-y}$, where it is assumed that the reaction product is Na_3MO_4, M = (U + Pu). With a knowledge of y and the heat of transport, the overall oxygen available for formation of a sodium-fuel reaction product was calculated for a given set of operating parameters in a fuel pin. In applying these data to several cases, the threshold compositions range from 1.93 to 1.97, depending on the heat rating of the fuel pin. In addition to oxygen available from the temperature gradient, release of excess oxygen during burnup will also contribute to the formation of the reaction product. The swelling relationship from these two sources of oxygen is about 1.2 vol %/0.01 change in O/M. The observed swelling changes in failed fuel ranges from 1 to 5 times higher than this rate, which is attributed to the tendency for nonuniform formation of the reaction product around the periphery of the fuel. From an analysis of the kinetics of swelling, the reaction product appears to form close to the defect in the cladding and grow by diffusion-controlled process away from the defect point toward the center of the fuel. 18 references. (auth)

60563 SODIUM-FUEL INTERACTIONS. **Blackburn, P. E.; Martin, A. E.; Battles, J. E.; O'Hare, P. A. G.; Hubbard, W. N. (Argonne National Lab., Ill.). pp 479-93 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).**

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Three programs at Argonne National Laboratory are underway to study the oxide fuel-sodium interaction. These investigations include: identification of the reaction product, thermodynamic properties of the reaction product, determination of the O/M ratio for the fuel at equilibrium, and reaction kinetic studies. The product of reaction between UO_{2+x} and Na was identified by x-ray and chemical analysis as Na_3UO_4, and between $U_{0.8}Pu_{0.2}O_2$ and Na was identified by x-ray analysis as $Na_3U_{1-y}O_4$. High-temperature mass spectrometric studies were carried out on Na_3UO_4 to establish the oxygen pressure in equilibrium with the equilibrium phases Na-UO_2-Na_3UO_4. Preliminary results of equilibrium studies and calculations from the mass spectrometric studies indicate the composition of $U_{0.8}Pu_{0.2}O_{2-x}$ fuel in equilibrium with sodium and the reaction product has an O/M ratio of 1.95 to 1.96 at 900°C. 6 references. (auth)

60564 PERFORMANCE OF MIXED-OXIDE FUEL ELEMENTS: ANL EXPERIENCE. **Lambert, J. D. B.; Neimark, L. A.; Murphy, W. F.; Dickerman, C. E. (Argonne National Lab., Ill.). pp 517-54 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).**

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

The examination of 12 mixed-oxide fuel elements from 3 separate EBR-II irradiations is described and the factors that governed element performance are discussed. Burnups ranged from 3 to 11 at. % with operation at 12 to 17 kW/ft in various fuel forms and densities. Eight elements were irradiated in capsules, whereas the remaining 4 were some of the first unencapsulated elements to achieve ~5 at. % burnup in EBR-II. Wire-wrapping caused element distortion that increased with reactor exposure. Fission gas release increased progressively with burnup and approached 90% at 10 at. %. Factors other than stainless-steel swelling contributed significantly to cladding diametral strain at burnups above 3 at. %. Thirty-mil-thick cladding appeared to offer greater restraint to fuel swelling than 15-mil-thick cladding at nearly equivalent burnups and power ratings. An element with an initial diametral fuel-cladding gap of 14 mils operated without center melting at 12 kW/ft and had closed its gap before 3 at. % burnup. Degradation of stainless-steel cladding by fission products seemed to be a complex phenomenon of corrosion and ablation of the cladding which involved the presence of cesium, iodine, molybdenum, tellurium, and oxygen at the fuel-cladding interface. The threshold temperature for cladding attack appeared to be 500°C. 14 references. (auth)

60565 STEADY-STATE PERFORMANCE OF PuO_2–UO_2 FAST REACTOR FUELS. **Craig, C. N.; Appleby, W. K.; Perry, K. J.; (and others) (General Electric Co., Sunnyvale, Calif.). Contract AT(04-3)-189. pp 555-78 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).**

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Irradiation tests and property studies are being carried out to develop mixed-oxide fuels for fast breeder reactors. Results from these tests continue to provide increased confidence that mixed-oxide-fueled reactors will be reliable, economic, and safe. Recent work has shown: (a) the concentration of plutonium increases in the center of pins operated above melting; (b) thermal conductivity of mixed oxide is dependent on stoichiometry; (c) fission gas release approaches 100% at burnups greater than 80,000 MWd/MT; (d) rate of release of fission gas from failed pins is dependent on the failure location; and (e) at high burnups fuel smeared density must be less than 84% to prohibit plastic cladding deformation. 10 references. (auth)

60566 DISTRIBUTION OF GASEOUS FISSION PRODUCTS IN IRRADIATED MIXED-OXIDE FUELS. **Johnson, C. E.; Steidl, D. V.; Crouthamel, C. E. (Argonne National Lab., Ill.). pp 603-13 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).**

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Data are presented which describe the distribution of residual fission gas (e.g., ^{85}Kr) in irradiated mixed-oxide fuels. Typical of the type of radial distribution observed is that for ^{85}Kr. The amount of ^{85}Kr in the columnar grain region near the central void was found to be larger than in the cooler end of the columnar grains and in the equiaxed-grain region with the largest amount of residual gas being found in the unrestructured region. Mechanisms are proposed to account for the observed behavior. 6 references. (auth)

60567 FUEL DYNAMICS EXPERIMENTS ON FAST REACTOR OXIDE FUEL PERFORMANCE UNDER TRANSIENT HEATING CONDITIONS USING THE TREAT REACTOR. **Dickerman, C. E.; Deitrich, L. W.; Robinson, L. E.; Rothman, A. B.; Carter, J. C. (Argonne National Lab., Ill.). pp 643-55 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).**

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Experimental studies of fast reactor fuel and coolant behavior under transient conditions associated with fuel failure are being performed in-pile using the Transient Reactor Test (TREAT) facility. The experiments are directed primarily toward the study of fuel movements; however, information concerning other phenomena (such as prefailure movements, secondary movements, mechanisms of failure, fuel-coolant interactions, coolant ejection, and pressure generation in both fuel and coolant) is also obtained in the course of the tests. Both fresh and previously irradiated fuel pins are used. Current work consists of oxide fuel-sodium coolant experimentation in support of AEC near-term reactor development efforts. Specific areas of accident analysis identified for this program include: response to power excursions, response to loss-of-flow, effects of local release of molten fuel or local channel blockages, modeling of slumping after loss-of-coolant, and phenomena governing subassembly containment of local failures. The principal test vehicle now in use is the Mark-II integral

TREAT loop, a loop self-contained inside the 4- × 8-in. cross section formed by removal of two adjacent TREAT elements. Results from the first seven loop tests on oxide LMFBR fuel samples are summarized. 16 references. (auth)

60568 OXIDE FUEL BEHAVIOR DURING TRANSIENT OVERPOWER CONDITIONS. **Thomas, Garry R.; Field, John H. (General Electric Co., Sunnyvale, Calif.). Contract AT(04-3)-189. pp 679-700 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).**

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

The test results indicate that molten oxide fuel is mobile; e.g., molten fuel extruded upward ~10 in. into a small diameter central hole in the blanket of one test. It is hypothesized that this movement resulted from the compression of fission and porosity gas entrained in the molten region, primarily resulting from volume changes during fuel-melt change of phase. The calculated forces resulting from such volume restraint, if constrained within the bounds of the fuel column, form the basic loading factor inducing failure in the present transient overpower fuel failure model (TOFF). A current test series involves the transient overpower characteristics of fuel pins previously irradiated to >50,000 MWd/MT in EBR-II. These test results should confirm the expected failure level of ~30 to 50% fuel volume melt (midplane value) for such high burnups. 11 references. (auth)

60569 IRRADIATION TESTING AND DEVELOPMENT OF FAST BREEDER REACTOR $(U,Pu)O_2$ FUEL RODS. **Lindgren, J. R. (Gulf General Atomic Co., San Diego, Calif.); Flynn, P. W.; Baldwin, N. L.; Fitts, R. B.; Longest, A. W. Jr. Contract AT(04-3)-167. pp 725-38 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).**

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

An irradiation test program employing both thermal and fast flux tests and a program for development of surface-roughened cladding are being conducted for development of fuel elements for the Gas-Cooled Fast Breeder Reactor (GCFR). The irradiation tests in progress are on 316 stainless-steel-clad $(U-Pu)O_2$ fuel rods. An instrumented and vented fuel rod containing a charcoal trap is undergoing thermal flux irradiation testing in the ORR. Fission gases at the inlet and exit of the trap are monitored under steady-state and cyclic conditions of power, temperature, and pressure. Operating conditions include a cladding outer surface temperature of ~700°C, a linear heat generation rate of 16 kW/ft. The fuel rod has operated satisfactorily and has reached an exposure of ~33,000 MWd/MT of a goal of 75,000 MWd/MT. The fast flux tests in EBR-II are being conducted to study the behavior of fuel rod specimens over a wider range of temperatures and to a higher range of cladding temperatures (600 to 800°C) than heretofore carried out in the LMFBR program. The irradiation of the capsules was started on March 2, 1971 toward burnup goals ranging from 25,000 to 100,000 MWd/MT. Heat transfer tests performed on surface-roughened rods with transverse ribs ranging from 2 mil high × 20 mil pitch to 4 mil high × 72 mil pitch show an enhancement of heat transfer by a factor of ~2. (auth)

60570 PERFORMANCE CAPABILITY OF ADVANCED FUELS FOR FAST BREEDER REACTORS. **Washburn, T. N.; Scott, J. L. (Oak Ridge National Lab., Tenn.). pp 741-52 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).**

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

The boundary limits of fuel performance are shown on plots of specific power (W/g) against linear power (kW/ft). For $(U,Pu)O_2$ fuels, these boundaries form a triangle with borders of about 100 W/g minimum specific power, about 0.200-in. minimum fuel diameter, and a maximum linear power of about 12 kW/ft for the core average or about 19 kW/ft for the highest rated fuel pin. For (U,Pu)C and (U,Pu)N fuels, the minimum specific power and minimum fuel diameter are the same as for the oxides. However, the higher thermal conductivity of these advanced fuels permits linear powers to about 30 kW/ft core average and about 45 kW/ft for the highest rated pin, when a sodium bond is used between the fuel and cladding to prevent excessive fuel temperatures and to provide space to accommodate fuel swelling. There is substantial economic advantage in operating fuel at these highly rated conditions, but a large amount of development work and irradiation testing must be performed with both the carbides and nitrides to permit an absolute comparison of their worth relative to oxides. (auth)

60571 SWELLING OF UC AND UN AT HIGH TEMPERATURES. **Hilbert, R. F.; Storhok, V. W.; Chubb, W.; Keller, D. L. (Battelle Memorial Inst., Columbus, Ohio). Contract W-7405-eng-92. pp 753-69 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).**

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

The external swelling behavior of UN was found to be superior to that of UC in irradiation tests of W−25 wt % Re-clad specimens at temperatures ranging from 1200 to 1700°C. In agreement with data which indicate that inert-gas diffusion and self-diffusion are more rapid in UC than in UN, fission gas bubbles and external fuel volume increases were larger in UC than in UN. The use of uniformly distributed porosity significantly reduced the swelling of UN and to a lesser extent reduced swelling of UC. 10 references. (auth)

60572 UNRESTRAINED SWELLING AND FISSION GAS RELEASE OF FAST REACTOR FUELS. **Grando, C.; Montgomery, M.; Strasser, A. (United Nuclear Corp., Elmsford, N. Y.). Contract AT(30-1)-3415. pp 771-84 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).**

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

The truly unrestrained swelling and fission gas release characteristics of various types of potential fast reactor fuels were measured in instrumented experiments. The experiments were irradiated in the Douglas United Nuclear Irradiation Testing Facility to burnups of 4.9×10^{20} and 7.0×10^{20} fiss/cm^3. Results of the unrestrained swelling tests were: The mixed carbides swelled at a $\Delta v/v$ of ~2.4% per 10^{20} fiss/cm^3 at 1300°C. In comparison, the restrained swelling rate of carbides at typical LMFBR temperature gradients has been found to range between 0.6 and 0.9% $\Delta v/v$ per 10^{20} fiss/cm^3. At temperatures of 1300°C, the unrestrained swelling rate of the mixed carbides is ~1.6 times as great as that of the mixed oxides. The mixed-oxide unrestrained swelling rate at 1600°C is ~1.7 times greater than that at 1300°C. The tests confirm that unrestrained swelling rates of both oxides and carbides are considerably higher than swelling rates of fuels restrained by cladding. Results of the fission gas release tests show that, at 1300°C, an average release of 18% of theoretical was recorded for the 84% of theoretically dense monocarbide, while fuel materials with densities of ≥90% released less than 8% of theoretical at the same operating temperature. 4 references. (auth)

60573 MIXED-NITRIDE FUEL IRRADIATION PERFORMANCE. **Bauer, A. A.; Brown, J. B.; Fromm, E. O.; Storhok, V. W. (Battelle Memorial Inst., Columbus, Ohio). Contract W-7405-eng-92. pp 785-817 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).**

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Mixed-nitride fuel irradiation behavior is reviewed with emphasis on recent results obtained for 24 specimens irradiated in the ETR and for a single, mixed-nitride fuel pin irradiated in the EBR-II. The thermal irradiations include specimens with helium- and sodium-bonded fuel irradiated to burnups in excess of 150,000 MWd/MTM at pin power heat ratings up to 49.8 kW/ft. Effects of fuel temperature and the presence of oxygen-stabilized U_2N_3 on fuel performance and swelling behavior and of fuel porosity and burnup on fission gas release behavior are described. The pin irradiated in EBR-II contained mixed-nitride fuel helium-bonded to Type 304 stainless-steel cladding and achieved a fuel burnup of 32,100 MWd/MTM at a peak linear power of 24.8 kW/ft. A cladding diameter change of about ½ mil (<0.2%) is assignable to cladding deformation by the swelling fuel. The presence of U_2N_3, in the absence of high oxygen contents, did not affect fuel irradiation performance. Excellent compatibility is exhibited between stainless-steel cladding and single-phase mixed-nitride fuel. Cladding in contact with fuel containing the U_2N_3 phase exhibited a reaction layer indicative of nitrogen penetration. 5 references. (auth)

60574 BEHAVIOR OF SODIUM-BONDED (U,Pu)C FUEL ELEMENTS AFTER MODERATE BURNUP. **Barner, J. O. (Los Alamos Scientific Lab., N. Mex.). pp 819-47 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).**

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Two sodium-bonded, single-phase, $(U_{0.8}Pu_{0.2})C$-fueled, Type 316 stainless-steel-clad fuel elements were irradiated in EBR-II at heating rates of ~30 kW/ft to burnups of 3.7 and 5.0 at. %. No cladding failures occurred as a result of the irradiation. Total fission gas release from the fuel was low. Thermal stresses in the fuel resulted in fuel splitting upon initial startup and general fuel fragmentation as fission product recoil and fast-neutron damage accumulated. No new phases were observed in the fuel after irradiation. 8 references. (auth)

60575 IRRADIATION OF HIGH-DENSITY (U,Pu)C PELLET FUEL RODS TO 65,000 MWd/MT BURNUP IN EBR-II. Strasser, A.; Montgomery, M.; Powers, R. (United Nuclear Corp., Elmsford, N. Y.). Contract AT(30-1)-3415. pp 849-67 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

This report summarizes the results of a series of helium-bonded, austenitic-clad, fuel rod irradiations with high-density uranium-plutonium carbide (U,Pu)C pellets in the fast reactor, EBR-II. The % $\Delta v/v$ of the fuel and cladding ranged from 0.6 to 0.9 per 10^{20} fiss/cm^3. The cladding diameter increase above which failure occurred was slightly over 1%. Incoloy-800 performed better than Type 316 stainless-steel cladding. The irradiated fuel microstructure was similar to the preirradiation structure, with the exception of the formation of fission gas bubbles and the disappearance of the sesquicarbide phase in the center of the high-power, high-burnup rods. The plutonium and fission product distribution in the fuel was uniform after irradiation. There were no identifiable reactions between the fuel, fission products, and the claddings. The results indicate that to reach a goal of 100,000 MWd/MT, fuel rods with high-density pellets will have to have a minimum of an 11% hot void which is an equivalent of 0.014 in. in diametral cold fuel-cladding gap for 0.25-in.-diam pellets. (Hot void is the amount of void space inside the cladding, within the fueled length, at the beginning-of-life temperature distribution. For these fuel rods, it is ~1% less than the cold smeared density.) 4 references. (auth)

60576 IRRADIATION BEHAVIOR OF SODIUM-BONDED MIXED-CARBIDE FUEL PINS. Harbourne, B. L. (Westinghouse Electric Corp., Madison, Pa.); Levine, P. J.; Latimer, T. W.; Neimark, L. A. Contract AT(30-1)-3791. pp 869-94 of Fast Reactor Fuel Element Technology. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Experimental fuel pins containing (U,Pu)C fuel sodium bonded to stainless-steel cladding have been irradiated in both thermal and fast flux environments. The fuels had additions of Cr or Fe, or were slightly hypostoichiometric. The additions were intended to improve swelling resistance and compatibility. Burnups up to 5.5 at. % at ratings up to 30 kW/ft were achieved without failure. Fragmentation of the fuel early in life resulted in cladding ovality even when the available bond volume had not been completely filled by fuel swelling. The Cr-modified fuel swelled least; the Fe-modified fuel swelled most. The differences in swelling behavior are attributed to the characteristics and amounts of second phases. The nature of the fuel-cladding reaction varied between fuel types, but was similar in extent. Neither additive seemed to suppress carbon transfer to the cladding. There is slight evidence of the loss-of-bond integrity in one pin, but apart from this these experiments demonstrate the viability of the sodium-bonded carbide fuel pin to moderate burnups. 9 references. (auth)

60577 ADVANCED THERMAL REACTOR FUGEN. Fujiki, I.; Kato, H.; Hayashi, K.; Akebi, M.; Kawada, T. (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryo Kogyo; 18: No. 3, 8-26(Mar 1972). (In Japanese).

Fugen is a heavy water moderated, boiling light water cooled prototype reactor with rated electric output of 165 MW(e). It will be critical about June 1975. The present design and developmental works are given. Items and main contents are as follows: core characteristics; fuel; reactor equipment; and instrumentation and control system. (Japan)

60578 STATUS AND PROBLEMS OF FAST REACTOR FUELS. Weber, Clifford E. (Atomic Energy Commission, Washington, D. C.). pp 43-65 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

Development of fast reactor fuels for use in the immediate and near-term future is described. Design and operating parameters are given for Fast Test Reactor and Liquid Mild Fast Breeder Reactor fuel elements. Radiation effect studies on fuel elements are discussed. (J.M.J.)

60579 FUEL PERFORMANCE LIMITS. Shewmon, P. G. (Argonne National Lab., Ill.). pp 201-12 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

$_{25}$From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

Methods for calculating the performance limits for fast reactor fuel elements are discussed. The term, "performance limit," is defined. It includes burnup, minor failures, and other causes or reasons for fuel element replacement. 7 references (J.M.J.)

60580 PLUTONIUM UTILIZATION IN FAST REACTORS. Golan, Simcha. pp 245-62 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

Performance and economic parameters for plutonium fuels for fast breeder reactors are given. Advantages of fast reactors vs. thermal reactors, i.e., burnup, specific inventory, specific power, etc., are given. (J.M.J.)

60581 FUEL ASSEMBLIES FOR THE GAS COOLED FAST REACTOR. Yellowlees, J. M. (Nuclear Power Group, Knutsford, Eng.); Chiarelli, G.; Libin, B.; Van Asbroeck, P. B. J. Brit. Nucl. Energy Soc.; 11: No. 4, 337-43(Oct 1972).

Three fuel assemblies for gas cooled fast reactor systems are described. One assembly uses vented fuel pins clad in stainless steel and cooled by helium. This assembly is similar in principle to an LMFBR assembly but the clad temperature is higher, the pin internal and external pressures are equalized and the clad employs external roughening to improve heat transfer. The other two assemblies use beds of coated particles directly cooled either by helium or by carbon dioxide. They permit gas temperatures similar to those in the HTR or in the AGR but with relatively low particle temperatures. (auth)

Operation and Economics

60582 (RT/EC-(72)1) STRATEGY OF ELECTRONUCLEAR DEVELOPMENT IN ITALY. COSTS–BENEFITS ANALYSIS AND MARKET VOLUME FOR QUALITY FUEL TO THE YEAR 2010. Comellini, O.; Tanzi, V.; Zironi, I. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 20 Mar 1972. 37p. (In Italian). Dep. NTIS (U. S. Sales Only).

On the basis of the expectations on the long-term electronuclear development of energy in Italy, the costs-benefits analysis and the Italian market estimates have been worked out for some significant strategies of electronuclear development in Italy. The economical advantages concerning the analyzed power programs are shown. There have been studied also the combinations of conventional plants and thermal reactors (LWR, HWR), fast reactors and thermal reactors (LWR, HWR, FBR) under different assumptions: some general conclusions are drawn on the economically optimum strategy and on the electronuclear market dimensions in Italy within the next ten years. In particular the remarkable importance is stressed of the fast reactor introduction not only for the energy program in the whole, but also to establish the most convenient mean- and long-term policy on fuel. (auth)

60583 EXPERIENCES DURING STARTUP OF THE COMPACT SODIUM-COOLED NUCLEAR ENERGY INSTALLATION KNK. Marth, W. KFK Nachr.; 4: No. 2, 24-8(1972). (In German).

Construction of the compact sodium-cooled nuclear reactor installation was started in May 1966 and completed in November 1969 as projected. The subsequent phase of startup, however, encountered several problems, causing a delay of about 19 months. Of the six steps comprising the startup phase, four were completed. Permission for step 5 (operation at 30% power) should be received in the near future. Step 6 (operation at 100% power) should be attained in late fall of 1972. Reasons for the 19 months delay were unforeseen single events with loss of time and money. All difficulties were surmounted and could be classified into six major categories: technical development program; computation methods; quality control; human errors; outlay of buildings and rooms; and licensing procedures. The six topics are discussed in detail. (H.B.G.)

60584 OVERALL VIEW OF THE NUCLEAR FUEL CYCLE. Mason, Edward A. (Massachusetts Inst. of Tech., Cambridge). pp 3-23 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

Reactor fuel cycles are described in general terms. Overall economics and methods of their computation are mentioned. Simple flowsheets are provided. Examples of types of materials, by reactor type, are provided in a table. 17 references (J.M.J.)

Safety and Siting

60585 (AI-AEC-13035) LMFBR SAFETY PROGRAMS. Annual Technical Progress Report, Government Fiscal Year 1972. (Atomics International, Canoga Park, Calif.). 15 Aug 1972. Contract AT(04-3)-824. 25p. Dep. NTIS.

FAST FLUX TEST FACILITY—coolant combustion accidents in, effects of sodium, (E/T)
LIQUID METAL FAST BREEDER REACTOR—safety research on, summary of fiscal year 1972
—coolant pipe rupture in, sodium jet discharge hydrodynamics for, (E/T)
—coolant combustion accidents in, release and transport of aerosols and energy from sodium, (E/T)
SODIUM—combustion in reactor accidents, release and transport of aerosols and energy from, (E/T)
URANIUM OXIDES UO_2—vaporization in reactor containment vessels, aerosol concentration and particle size from, (E/T) (H.D.R.)

60586 (GULF-GA-A-12021) FIPER-II, A NUMERICAL SOLUTION OF TWO-DIMENSIONAL DIFFUSION AND ADSORPTION PROBLEMS. Appel, J.; Forutanpour, B.; Roos, B. (Gulf General Atomic Co., San Diego, Calif.). Jul 1972. Contract AT(04-3)-167. 96p. Dep. NTIS.

The prediction of the degree of release of metallic fission products into the helium coolant of a High Temperature Gas Cooled Reactor system requires accurate calculational methods and basic input information consisting of diffusion, adsorption, and fuel particle release data. The mathematical model and program listing are presented for the FIPER-II code for the solution of the fission product transport equation in two dimensions and as a function of time. Results are presented for application of the code to a cylindrical diffusion problem. (H.D.R.)

60587 DESIGN BASIS ACCIDENTS OF LIGHT-WATER REACTOR POWER PLANTS. Togo, Y. (Tokyo Univ.). Kuki Seijo; 8: No. 7, 2-6(Mar 1971). (In Japanese).

Prior to the installation of nuclear power plants, safety assessment is carried out to evaluate the reasonableness of plant design, adaptability of site, and to secure the safety of the public. Serious accidents to be taken into account in the safety assessment in Japan are classified in two types, that is, major accidents and hypothetical accidents. Safety equipment provided to prevent or to reduce release of radioactivity from these accidents is called engineering safety facilities. The general view of engineering safety facilities employed in light-water reactor power plants is presented. Coolant loss accidents with and without emergency core cooling systems working are analyzed with regard to the release of radioactivity. (Japan)

60588 SUMMARY OF THE SAFETY WORK ON SOME GAS BREEDER REFERENCE DESIGNS. Decamps, F.; Stanbridge, J. R.; Turrini, E. (Gas Breeder Reactor Association, Brussels). J. Brit. Nucl. Energy Soc.; 11: No. 4, 345-52(Oct 1972).

Safety studies are described that were carried out on reactor reference designs selected for detailed study and incorporating both pin and coated particle fuel. Particular problems are the integrity of the primary circuit at high coolant pressures and the provision of both reliable and sufficient emergency coolant flow in the event of a depressurization accident. The engineering of the plant is briefly described and the results of a number of fault studies are given. (auth)

Commercial Power Reactors

Refer also to abstract 60744.

60589 (FIND-50397(9-72)) FIND: HANFORD NO. 2 NUCLEAR POWER PLANT. Smith, James G. (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). 29 Sep 1972. 23p. Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

60590 (RDT-INDEX-9-72) INDEX OF RDT STANDARDS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Sep 1972. 28p. RSO.

60591 (TID-26165) COMPETITION IN THE NUCLEAR POWER SUPPLY INDUSTRY. PART ONE. OVERVIEW: SUMMARY AND GOVERNMENT POLICY IMPLICATIONS. (Little (Arthur D.) Inc., [Cambridge, Mass.]). 1 Nov 1968. Contract AT(30-1)-3853. 110p. Dep. NTIS.

The central purpose of this study is to provide background information and economic data on the growing nuclear industry, which, in turn, should provide the Commission and the Department of Justice with a firmer factual basis for the possible development of the kind of determinations best designed to foster healthy competition in this industry. The study also reviews various possible objectives of the Government in developing a competitive industry and presents approaches that might be used in achieving desired objectives. (auth)

60592 GENERAL ASPECTS OF NUCLEAR POWER PLANTS. Ortega, O. J. pp IV.1-105 of Environment. Los Angeles; Southern California Edison Co. (1971).

Design and operation principles for pressurized water and boiling water reactor power plants are presented. Fundamentals of nuclear radiation with respect to nuclear power plants are given. The nuclear fuel cycle is briefly described for the various types of fuels. (J.M.J.)

60593 DESIGN PHILOSOPHY OF AN AGR REACTOR. Ramirez, A. C. Mexico City; Universidad Nacional Autonoma de Mexico (1972). 170p. (In Spanish).

Thesis.

The design of an AGR-type reactor for possible use in Mexico is detailed. (J.S.R.)

Physics and Core Engineering

60594 (GULF-GA-A-12200) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(e) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1972. (Gulf General Atomic Co., San Diego, Calif.). 31 Jul 1972. Contract AT(04-3)-633. 36p. Dep. NTIS.

The research and development program for the Public Service Company of Colorado 330-MW(e) High-temperature Gas-cooled Reactor is described. The work reported includes nuclear analysis of the fuel cycle, fuel zoning, and power shaping. The fuel development and fuel element proof testing portions of the report include demonstration testing of the performance of test fuel elements by means of irradiation at expected operating temperatures and capsule irradiation tests of production fuel. (auth)

Control and Instrumentation

60595 SPECIAL HYBRID COMPUTER FOR THE SPACE-TIME CALCULATIONS OF POWER COEFFICIENTS IN LARGE PRESSURIZED WATER REACTOR CORES FOR OPTIMIZATION OF CONTROL ELEMENTS AND CONTROL ROD DRIVE PROGRAMS. Aleite, W. (Siemens AG, Erlangen, Ger.); Bock, H. W. pp 507-12 of Conference on Hybrid Computation. Brussels; Presses Academiques Europeenes (1970). (In German).

From sixth conference on hybrid computation; Munich, Germany (31 Aug 1970). See CONF-700826.

Coolant System

60596 (GULF-GA-B-10034) PARTICULATE MATTER IN THE PEACH BOTTOM HTGR PRIMARY COOLANT SYSTEM. Results of Postconstruction R and D Test JM-14, "Removal and Analysis of Main-Loop Particulate Matter." Busch, D. D. (Gulf General Atomic Co., San Diego, Calif.). 7 Jul 1972. Contract AT(04-3)-314. 55p. Dep. NTIS.

Particulate matter present in small quantities in the primary circuit of the Peach Bottom High-Temperature Gas-Cooled Reactor was studied. Samples were collected and analyzed in order to characterize the particulate matter, and to determine its role in the transport and deposition of fission products. Throughout Core 1 operation, the particulate matter consisted primarily of construction debris—weld spatter, grinding chips, shreds of stainless steel insulation, fibrous wool-like material, and fine black dust. Fuel compact material began appearing as cracks developed in certain fuel element sleeves, but the amounts were very small. At 300 equivalent full-power days, with about 1.4% of the fuel element sleeves cracked, only 4×10^{-7} fraction of the fuel compact material was estimated to have been released to the primary coolant. Less than three hundred grams of particulate matter of all kinds were removed from the primary circuit dust separators during Core 1 operation. Thin, generally adherent black deposits, "sooty" in appearance, were noted on core components. These deposits appear to consist primarily of carbon and iron. Reactor operations are not affected by the thin deposits and particulate matter present in the Peach Bottom primary coolant system. (auth)

60597 ESTIMATION OF CONTINUOUS PURIFICATION OF THE PRIMARY WATER COOLANT IN PRESSURIZED WATER REACTORS. Herold, C.; Winkler, R.; Langecker, K. (VEB KKW Greifswald-Rheinsberg, Lehr- und Versuchskraftwerk, Rheinsberg, Ger.). Kernenergie; 15: No. 5, 152-6(May 1972). (In German).

An estimation of continuous purification of primary water coolant is given on the basis of several years' operating experiences and recent data published in the international literature. The traditional tasks of a primary water coolant purification plant either proved to be unproblematical or were unsufficiently fulfilled or have to be corrected because of well-grounded new requirements. For more recent tasks resulting from modified materials and use of boric acid, equivalent technological solutions for a primary water coolant purification plant are possible. (auth)

60598 HYBRID COMPUTER MODEL FOR A COUNTER-FLOW HEAT EXCHANGER USING THE CSDT-METHOD. Beijdorff, A. F. (Delft Univ. of Tech., Netherlands); De Hes, M. pp 479-87 of Conference on Hybrid Computation. Brussels; Presses Academiques Europeenes (1970).

From sixth conference on hybrid computation; Munich, Germany (31 Aug 1970). See CONF-700826.

A mathematical model of a counterflow heat exchanger consists of a set of two boundary valued partial differential equations describing fluid temperatures, coupled by a partial differential equation with mixed boundary conditions representing heat transfer through the separating tube wall. This set is solved with a hybrid computer by discretizing time and integrating continuously with respect to both axial and radial independent space variables. By splitting up the wall's thermal capacity also a simplified model is derived needing few analog components and little digital attention. In addition to a description of these models some graphs are given with results of calculations. 7 references. (auth)

60599 SIMULATION MODEL FOR FLOW DISTRIBUTION IN A THERMAL REACTOR (AS EXEMPLIFIED IN PRESSURIZED WATER REACTORS). Gilles, Ernst D.; Stark, Klaus (Univ., Stuttgart). pp 496-506 of Conference on Hybrid Computation. Brussels; Presses Academiques Europeenes (1970). (In German).

From sixth conference on hybrid computation; Munich, Germany (31 Aug 1970). See CONF-700826.

Fuels and Fuel Elements

60600 (EUR-4148) TRITON: A MULTI-GROUP DIFFUSION-DEPLETION PROGRAM IN THREE DIMENSIONS FOR IBM-360. Daneri, A.; Maggioni, G.; Salina, E. (FIAT, Turin (Italy). Sezione Energia Nucleare). May 1968. 99p. (FNE-E-97). Dep. NTIS (U. S. Sales Only).

TRITON is a multi-group diffusion depletion code in three dimensions, with criticality searches, written in Fortran IV for IBM-360. Some outstanding features of TRITON are: more sets of cross section libraries and self-shielding factors, 3 types of criticality searches, in addition to the straight burnup calculation, possibilities of changing sets of data at prefixed time-steps, 2 types of restart of interrupted problems, arbitrary isotopic chains, and automatic fuel shuffling. In order to have TRITON readily modifiable for adaptation to other machines of the 360 series, but with different maximum storage availabilities, the dimensions of the program (that is the maximum number of groups, compositions, regions, mesh-points, burnable isotopes, and so on) are parametric. (auth)

60601 ONE-POINT FOUR-GROUP ALGORITHM FOR COMPUTING THE NUCLEAR FUEL DEPLETION OF PWR. Apostolov, T. G.; Kolev, N. P. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 25: No. 4, 467-70(1972).

60602 STATUS AND PROBLEMS OF THERMAL REACTOR FUELS. Richards, R. B. (General Electric Co., San Jose, Calif.). pp 25-41 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

Development and performance of fuel elements for pressurized and boiling water thermal power reactors are reviewed. 26 references. (J.M.J.)

60603 IN-CORE FUEL MANAGEMENT AT COMMONWEALTH EDISON COMPANY. Veras, A. F. (Commonwealth Edison Co., Chicago). pp 213-33 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

Fuel cycles for boiling and pressurized water reactors are outlined and explained. Methods used by Commonwealth Edison Co. to obtain the most economic performance of its power reactors are discussed. (J.M.J.)

60604 PLUTONIUM UTILIZATION IN THERMAL REACTORS. Haley, J. pp 235-44 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

Non-utilization of plutonium for reactor fuels imposes an economic penalty on power reactor operation. The cost of stockpiling uranium bed in thermal reactors makes it uneconomical to wait for commercial breeder reactor use in mid-1980's. Problems of plutonium utilization are described. (J.M.J.)

60605 EVALUATION OF THORIUM FUEL CYCLES. Kasten, Paul R. (Oak Ridge National Lab., Tenn.). pp 263-87 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

The thorium fuel cycle is evaluated for most types of thermal power reactors. Abundance of thorium, breeding levels, reprocessing costs, fabrication costs, etc., is discussed. It is concluded that the thorium cycle is economical for molten salt, high temperature, and fast reactors, but not light water reactors. 18 references. (J.M.J)

Operation and Economics

60606 (DOCKET-50016-172) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Report for July 1972. (Power Reactor Development Co., Detroit, Mich.). 12 Oct 1972. 14p. (PRDC-EF-107). Dep. NTIS.

60607 (DOCKET-50029-205) YANKEE NUCLEAR POWER STATION. Failure of an Emergency Diesel Generator to Start on October 4, 1972. (Yankee Atomic Electric Co., Rowe, Mass.). 10 Oct 1972. 1p. Dep. NTIS.

60608 (DOCKET-50029-206) YANKEE NUCLEAR POWER STATION. Operation Report No. 140 for the Month of August 1972. (Yankee Atomic Electric Co., Westboro, Mass.). Sep 1972. 8p. Dep. NTIS.

60609 (DOCKET-50029-207) YANKEE NUCLEAR POWER STATION. Operation Report 141, September 1972. (Yankee Atomic Electric Co., Westboro, Mass.). Oct 1972. 7p. Dep. NTIS.

60610 (DOCKET-50146-112) SAXTON NUCLEAR EXPERIMENTAL REACTOR PROJECT. Status of Decommissioning Activities. (Saxton Nuclear Experimental Corp., Pa.). 11 Oct 1972. 2p. Dep. NTIS.

60611 (DOCKET-50213-164) HADDAM NECK PLANT, UNIT 1. Operation Report 72-9 for the Month of September 1972. (Connecticut Yankee Atomic Power Co., Haddam). 20 Oct 1972. 13p. (NYO-3144-76). Dep. NTIS.

60612 (DOCKET-50244-122) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Monthly Report of Activity Measurements. (Rochester Gas and Electric Corp., N. Y.). 16 Oct 1972. 2p. Dep. NTIS.

60613 (DOCKET-50245-161) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence AO-72-23. (Millstone Point Co., Hartford, Conn.). 21 Sep 1972. 2p. Dep. NTIS.

Information is presented concerning the incorrect calibration of the reactor low low level switch. (D.C.C.)

60614 (DOCKET-50245-168) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Provisional Operating License, Amendment 1. (Directorate of Licensing (AEC), Washington, D. C.). 11 Oct 1972. 2p. Dep. NTIS.

60615 (DOCKET-50250-97) TURKEY POINT PLANT, UNIT 3. Steps Taken to Correct the Items of Noncompliance Brought to Attention in Letter Dated August 25, 1972. (Directorate of Regulatory Operations (AEC), Atlanta, Ga. (USA). Region II). 20 Sep 1972. 7p. Dep. NTIS.

Requested information is presented concerning the quality assurance requirements for core loading procedures and the identification of fuel assemblies. (D.C.C.)

60616 (DOCKET-50254-132) QUAD-CITIES STATION, UNITS 1 AND 2. High Pressure Coolant Injection System Failed to Operate in the Test Mode. (Commonwealth Edison Co., Cordova, Ill.). 21 Oct 1972. 1p. (DOCKET-50265-123). Dep. NTIS.

60617 (DOCKET-50255-106) PALISADES PLANT. Monthly Primary and Secondary Radioactivity and Effluent Report, September 1972. (Consumers Power Co., Jackson, Mich.). 24 Oct 1972. 2p. Dep. NTIS.

60618 (DOCKET-50263-155) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. No. 12 Emergency Diesel Generator, No. 1 Starting System Malfunction. (Northern States Power Co., Minneapolis, Minn.). 13 Oct 1972. 1p. Dep. NTIS.

60619 (DOCKET-50266-86) POINT BEACH NUCLEAR PLANT, UNIT 1. Technical Specifications, Request for Change 4. (Wisconsin Electric Power Co., Milwaukee). 17 Oct 1972. 5p. Dep. NTIS.

Revised technical specifications are presented concerning operations with a fuel element test assembly. (D.C.C.)

60620 (DOCKET-50267-47) FORT ST. VRAIN NUCLEAR GENERATING STATION. Environmental Radiation Surveillance Program Report, January 1-June 30, 1972. (Colorado State Univ., Fort Collins). 28 Aug 1972. Contract FSV-00027. 70p. Dep. NTIS.

For Public Service Co. of Colorado, Denver.

60621 (DOCKET-50270-54) OCONEE NUCLEAR STATION, UNITS 2 AND 3. Application for Licenses, Amendment 36. (Duke Power Co., Charlotte, N. C.). 16 Oct 1972. 2p. (DOCKET-50287-49). Dep. NTIS.

Additional information is presented concerning the estimated operating revenue and decommissioning costs for the Oconee Power Reactor Units 2 and 3. (D.C.C.)

60622 (DOCKET-50271-103) VERMONT YANKEE NUCLEAR POWER STATION. Abnormal Occurrence AO-72-06. (Vermont Yankee Nuclear Power Corp., Rutland). 29 Sep 1972. 2p. Dep. NTIS.

Information is presented concerning the repair of a broken lead to the steam line switch for the core isolation cooling system. (D.C.C.)

60623 (DOCKET-50272-42) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Notice of Consideration of Issuance of Facility Operating Licenses and Notice of Opportunity for Hearing. (Directorate of Licensing (AEC), Washington, D. C.). 6 Oct 1972. 7p. (DOCKET-50311-42). Dep. NTIS.

60624 (DOCKET-50293-92) PILGRIM NUCLEAR POWER STATION. Abnormal Occurrence AO-72-9. (Boston Edison Co., Mass.). 3 Oct 1972. 3p. Dep. NTIS.

Information is presented concerning the failure of the residual heat removal system torus cooling valve stem key. Corrective actions are described. (D.C.C.)

60625 (DOCKET-50293-94) PILGRIM NUCLEAR POWER STATION. Abnormal Occurrence AO-7210. (Boston Edison Co., Mass.). 28 Sep 1972. 3p. Dep. NTIS.

Information is presented concerning an incorrect low low water level set point for initiating the core standby cooling system. Corrective actions are described. (D.C.C.)

60626 (TRG-Report-2315) ECONOMIC ASSESSMENT OF REACTOR SYSTEMS. Iliffe, C. E.; Wright, J. K. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1972. 24p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

The "present worth" approach is used to obtain a method of costing electricity generation from any nuclear power program. In this approach it is unnecessary to feed in a monetary value of Pu. Instead, a minimum selling price for Pu is derived. The electricity cost so obtained is a "discounted" unit cost and in the case of a single station it is shown that this cost may be identified with the one normally calculated if Pu transactions are excluded. The costing basis developed may be applied to a programme of nuclear power stations by the digital computer programme DISCOUNT. Three reactor types are considered, an obsolescent thermal, an advanced thermal, and a fast reactor. Two extreme power programmes may be dealt with, a "maximum" programme in which all new stations after the introduction of fast reactors are nuclear, and a "base" programme in which nuclear capacity increases to meet the base load and no further. Pu stockpiling may start at any time before fast reactors are introduced, prior to which account is taken of any receipts from Pu sales. The three reactor types may be placed in any order of load factor. The programme prints out variation with time of installed capacity and load factor of the three different reactor types, discounted unit cost, and minimum plutonium selling price. A worked example is given. 4 references. (auth)

60627 TECHNISCH-OEKONOMISCHE ANALYSE "SCHNELLE BRUETER." (Technical-Economical Analysis "Fast Breeders") Syros, C. Brussels; Kommission der Europaeischen Gemeinschaften (1972). 91p.

A quantitative systems analysis method for the economic comparison of the (sodium cooled) fast breeder reactors with the light water reactors was developed. Costs for development, construction and operation of FBR and LWR were calculated as functions of the most important physical and technological parameters and compared with each other. Included were thermodynamic efficiency, reactor life-time, residence time of the fuel etc. It was assumed that the Pu will be used as LWR-fuel. Radiation effects on structural materials of the FBR were considered. 69 references. (auth)

60628 FUEL CYCLE ECONOMICS. Hang, Daniel F. (Univ. of Illinois, Urbana). pp 67-83 of Education and Research in the Nuclear Fuel Cycle. /Elliott, David M. (ed.). Norman, Okla.; Univ. of Oklahoma Press (1972).

From Meeting on education and research in the nuclear fuel cycle; Norman, Okla. (5 Oct 1970). See CONF-701035.

An economic study of reactor fuel cycles is presented. Methods for calculating specific costs are given. 10 references. (J.M.J.)

Safety and Siting

Refer also to abstract 58780.

60629 (BN-TOP-2) DESIGN FOR PIPE BREAK EFFECTS. Revision 0. (Bechtel Corp., San Francisco, Calif.). 25 Sep 1972. 34p.

Nuclear plant design considerations for protection against the consequences of a hypothetical pipe break are set forth in terms of criteria for plant and public safety, hypothetical pipe break accident description, assumptions and analysis methods to establish restraint design criteria, and calculational techniques for fluid jet impingement forces. 8 references. (auth)

60630 (CONF-711058-1) DEMOGRAPHIC POLICY AND POWER PLANT SITING. Weinberg, Alvin M. (Oak Ridge National Lab., Tenn.). 13 Oct 1971. 8p. Dep. NTIS.

From Symposium on energy policy and national goals; Washington, D. C. (20 Oct 1971).

The need for redistribution of U.S. population from dense, overpopulated cities to sparsely populated rural areas is reiterated. The possibility of inducing this redistribution by the planning of power centers in areas where population centers are desired is proposed. Both social and economic parameters are considered. 9 references. (J.M.J.)

60631 (DOCKET-50003-133) INDIAN POINT STATION, UNIT 1. Additional Information on Modified Design of Thermal Sleeve; Errata. (Consolidated Edison Co. of New York, Inc., New York). 16 Oct 1972. 2p. Dep. NTIS.

60632 (DOCKET-50010-121) DRESDEN NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Review of Facilities to Resist Flooding Capabilities. (Commonwealth Edison Co., Chicago, Ill.). 13 Oct 1972. 5p. (DOCKET-50237-267; DOCKET-50249-164). Dep. NTIS.

60633 (DOCKET-50016-171) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. No Further Operation at Powers in Excess of 1 MWt. (Power Reactor Development Co., Detroit, Mich.). 13 Oct 1972. 1p. Dep. NTIS.

60634 (DOCKET-50029-204) YANKEE NUCLEAR POWER STATION. Control Rod Drop Times September 30, 1972. (Yankee Atomic Electric Co., Westboro, Mass.). 2 Oct 1972. 2p. Dep. NTIS.

60635 (DOCKET-50171-107) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Response to Letter of June 27, 1972 Concerning Possible Flood Effects. (Philadelphia Electric Co., Pa.). 29 Jun 1972. 1p. Dep. NTIS.

60636 (DOCKET-50206-172) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Flooding of Critical Equipment.

(Southern California Edison Co., Rosemead, Calif.). 5 Oct 1972. 3p. Dep. NTIS.

60637 (DOCKET-50206-173) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Applicants' Environmental Report, Operating License Stage, Volume I. (Southern California Edison Co., Rosemead, Calif. San Diego Gas and Electric Co., Calif.). 31 Aug 1972. 284p. Dep. NTIS.

The environmental effects of construction and operation of the San Onofre Power Reactor Unit 1 are examined. The descriptions include: description of the plant and site; need for power; location of the plant; human activities in the environs; historic significance; geology; hydrology and oceanography; meteorology; biota of the San Onofre area; external appearance of the plant; transmission lines; reactor and steam—electric systems; water use; heat dissipation system; radwaste systems; and chemical and sanitary waste systems. (D.C.C.)

60638 (DOCKET-50206-174) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Applicants' Environmental Report, Operating License Stage, Volume II. (Southern California Edison Co., Rosemead, Calif. San Diego Gas and Electric Co., Calif.). 31 Aug 1972. 420p. Dep. NTIS.

The environmental effects of construction and operation of the San Onofre Power Reactor Unit 1 are examined. The descriptions include: environmental effects of plant operation; environmental effects of accidents; unavoidable adverse effects; short-term uses and long-term productivity; resources committed in plant operation; summary of alternatives to plant operation; summary of costs and benefits; and environmental approvals and consultation. (D.C.C.)

60639 (DOCKET-50213-161) HADDAM NECK PLANT, UNIT 1. Environmental Report, Amendment 1 and Addenda 3. (Connecticut Yankee Atomic Power Co., Hartford). 6 Oct 1972. 143p. Dep. NTIS.

The environmental report for the Connecticut Yankee Power Reactor is amended by the submission of requested additional information. A report on the environmental radiation survey program for January through June 1972 is presented. (H.D.R.)

60640 (DOCKET-50213-162) HADDAM NECK PLANT, UNIT 1. Flooding of Critical Equipment. (Connecticut Yankee Atomic Power Co., Hartford). 6 Oct 1972. 2p. Dep. NTIS.

60641 (DOCKET-50213-163) HADDAM NECK PLANT, UNIT 1. Abnormal Occurrence 72-3. (Connecticut Yankee Atomic Power Co., Haddam). 13 Oct 1972. 1p. Dep. NTIS.

60642 (DOCKET-50219-218) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Inoperable Standby Liquid Control System. (Jersey Central Power and Light Co., Morristown, N. J.). 6 Oct 1972. 2p. Dep. NTIS.

60643 (DOCKET-50219-219) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Flooding of Critical Equipment. (Jersey Central Power and Light Co., Morristown, N. J.). 9 Oct 1972. 2p. Dep. NTIS.

60644 (DOCKET-50237-268) DRESDEN NUCLEAR POWER STATION, UNIT 2. Design Modification to Supports to Recovery Cones. (Commonwealth Edison Co., Chicago, Ill.). 2 Oct 1972. 6p. Dep. NTIS.

The downstream cones of the main steam line flow restrictors were modified by the addition of axial and lateral supports. These supports prevent movement of the cones due to vibration and prevent the cone from moving downstream in the event the cone-to-throat weld fails. (H.D.R.)

60645 (DOCKET-50237-269) DRESDEN NUCLEAR POWER STATION, UNIT 2. Results of Primary Containment Leak Rate Test. (Commonwealth Edison Co., Chicago, Ill.). 10 Oct 1972. 29p. Dep. NTIS.

60646 (DOCKET-50244-121) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. October 1972 Shutdown to Replace Remaining First Core Fuel. (Rochester Gas and Electric Corp., N. Y.). 29 Sep 1972. 4p. Dep. NTIS.

60647 (DOCKET-50245-162) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence AO-72-24. (Millstone Point Co., Hartford, Conn.). 4 Oct 1972. 2p. Dep. NTIS.

60648 (DOCKET-50245-169) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Technical Specifications, Change 9. (Directorate of Licensing (AEC), Washington, D. C.). 12 Oct 1972. 5p. Dep. NTIS.

Revised technical specifications are presented concerning primary containment leak rate test requirements. (D.C.C.)

60649 (DOCKET-50249-165) DRESDEN NUCLEAR POWER STATION, UNIT 3. Setpoints of Two Reactor Low Pressure Permissive Switches Drifted. (Commonwealth Edison Co., Chicago, Ill.). 13 Oct 1972. 2p. Dep. NTIS.

60650 (DOCKET-50250-96) TURKEY POINT PLANT, UNIT 3. Technical Specifications, Change 1. (Directorate of Licensing (AEC), Washington, D. C.). 6 Sep 1972. 4p. Dep. NTIS.

Revised technical specifications are presented concerning power tilt limits. (D.C.C.)

60651 (DOCKET-50250-98) TURKEY POINT PLANT, UNIT 3. Abnormal Occurrence No. 3-72-6 on August 29 and 30, 1972. (Florida Power and Light Co.). 29 Sep 1972. 3p. Dep. NTIS.

60652 (DOCKET-50254-130) QUAD-CITIES STATION, UNITS 1 AND 2. Additional Information Concerning Condensate Pump Room Modifications. (Commonwealth Edison Co., Chicago, Ill.). 13 Oct 1972. 3p. (DOCKET-50265-122). Dep. NTIS.

60653 (DOCKET-50254-131) QUAD-CITIES STATION, UNIT 1. Special Report No. 3, Residual Heat Removal Condensate Pump Room Modifications. (Commonwealth Edison Co., Chicago, Ill.). 18 Oct 1972. 30p. Dep. NTIS.

60654 (DOCKET-50255-105) PALISADES PLANT. Provisional Operating License DPR-20, Amendment 4. (Directorate of Licensing (AEC), Washington, D. C.). 16 Oct 1972. 237p. Dep. NTIS.

The provisional operating license for the Palisades Power Reactor is amended to allow operation at 2200 MW(t). An Atomic Safety and Licensing Appeal Board decision and the plant Technical Specifications are included. (H.D.R.)

60655 (DOCKET-50259-66) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 41. (Tennessee Valley Authority, Chattanooga). 27 Sep 1972. 69p. (DOCKET-50260-62; DOCKET-50296-59). Dep. NTIS.

The final safety analysis report for the Browns Ferry Power Plant, Units 1, 2, and 3 is amended by the submission of revised information and responses to questions on post-LOCA hydrogen control. (H.D.R.)

60656 (DOCKET-50259-68) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 43. (Tennessee Valley Authority, Chattanooga). 13 Oct 1972. 84p. (DOCKET-50260-64; DOCKET-50296-61). Dep. NTIS.

The final safety analysis report for the Browns Ferry Power Reactor, Units 1, 2, and 3 is amended by the submission of a design and performance analysis for a control rod sequence control system to prevent out-of-sequence rod movement during startup or shutdown. Also included are revised information and responses to requests for additional information. (H.D.R.)

60657 (DOCKET-50261-113) H. B. ROBINSON UNIT 2. Flooding of Critical Equipment. (Carolina Power and Light Co., Raleigh, N. C.). 22 Sep 1972. 2p. Dep. NTIS.

60658 (DOCKET-50261-116) H. B. ROBINSON UNIT 2. Technical Specifications, Change 9. (Directorate of Licensing (AEC), Washington, D. C.). 16 Oct 1972. 2p. Dep. NTIS.

Revised technical specifications are presented concerning the automatic hot leg injection capability of the emergency core cooling system. (D.C.C.)

60659 (DOCKET-50266-84) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Activation of Seismic Recorders. (Wisconsin Electric Power Co., Milwaukee). 6 Oct 1972. 2p. (DOCKET-50301-75). Dep. NTIS.

60660 (DOCKET-50266-85) POINT BEACH NUCLEAR PLANT, UNIT 1. Failure to Maintain Minimum Operational Safety Instrumentation. (Wisconsin Electric Power Co., Milwaukee). 9 Oct 1972. 2p. Dep. NTIS.

60661 (DOCKET-50269-66) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Steps Taken With Respect to the Item of Apparent Noncompliance Brought to Attention in Letter Dated August 30, 1972. (Directorate of Regulatory Operations (AEC), Atlanta, Ga. (USA). Region II). 4 Oct 1972. 5p. (DOCKET-50270-53; DOCKET-50287-48). Dep. NTIS.

60662 (DOCKET-50271-107) VERMONT YANKEE NUCLEAR POWER STATION. Facility Operating License No. DPR-28, Amendment 3. (Directorate of Licensing (AEC), Washington, D. C.). 12 Oct 1972. 9p. Dep. NTIS.

60663 (DOCKET-50272-36) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Shoreline Investigation and Oceanographic Study. (Dames and Moore, Cranford, N. J. (USA)). 13 Sep 1972. 49p. (DOCKET-50311-36). Dep. NTIS.
For Public Service Electric and Gas Co., Newark, N. J.

60664 (DOCKET-50272-40) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 15. (Public Service Electric and Gas Co., Newark, N. J.). 2 Oct 1972. 209p. (DOCKET-50311-40). Dep. NTIS.

Revised and requested data are presented concerning radioactive effluents; engineered safeguards; site; safety analysis; instrumentation; and the quality assurance program. (D.C.C.)

60665 (DOCKET-50272-41) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Environmental Report and Supplemental Environmental Report, Amendment 3. (Public Service Electric and Gas Co., Newark, N. J.). 16 Oct 1972. 41p. (DOCKET-50311-41). Dep. NTIS.

60666 (DOCKET-50277-60) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Amendment 21. (Philadelphia Electric Co., Pa.). 29 Sep 1972. 10p. (DOCKET-50278-61). Dep. NTIS.

Additional information is presented concerning emergency cooling systems and radioactive effluents from the reactors. (D.C.C.)

60667 (DOCKET-50277-63) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Draft Environmental Statement. (Philadelphia Electric Co., Pa.). Oct 1972. 352p. (DOCKET-50278-64). Dep. NTIS.

The environmental effects of construction and operation of the Peach Bottom Power Reactor Units 2 and 3 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

60668 (DOCKET-50280-87) SURRY POWER STATION, UNIT 1. Abnormal Occurrence Report, October 1, 1972. (Virginia Electric and Power Co., Richmond). 11 Oct 1972. 6p. Dep. NTIS.

On October 1, 1972, a gasket failed on a swing check valve bonnet in a feedwater supply line to steam generator A of the Surry Power Reactor, Unit 1. The gasket failure resulted in an excessive cooldown rate and pressurization of the containment due to a feedwater leak. An analysis of the occurrence and the corrective actions taken are presented. (H.D.R.)

60669 (DOCKET-50282-76) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Notice of Consideration of Issuance of Facility Operating Licenses and Notice of Opportunity for Hearing. (Directorate of Licensing (AEC), Washington, D. C.). 11 Oct 1972. 6p. (DOCKET-50306-72). Dep. NTIS.

60670 (DOCKET-50282-77) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 24. (Northern States Power Co., Minneapolis, Minn.). 6 Oct 1972. 68p. (DOCKET-50306-73). Dep. NTIS.

The final safety analysis report for the Prairie Island Power Reactor, Units 1 and 2, is amended by the submission of revised and additional information. (H.D.R.)

60671 (DOCKET-50282-78) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Safety Evaluation. (Directorate of Licensing (AEC), Washington, D. C.). 28 Sep 1972. 189p. (DOCKET-50306-74). Dep. NTIS.

60672 (DOCKET-50285-73) FORT CALHOUN STATION, UNIT 1. Supplemental Information Regarding Alternate Discharge System. (Nebraska Public Power District, Columbus). 13 Oct 1972. 1p. Dep. NTIS.

60673 (DOCKET-50286-55) INDIAN POINT NUCLEAR GENERATING UNIT 3. Notice of Consideration of Issuance of Facility Licnese and Notice of Opportunity for Hearing. (Directorate of Licensing (AEC), Washington, D. C.). 19 Oct 1972. 6p. Dep. NTIS.

60674 (DOCKET-50289-69) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Final Safety Analysis Report, Amendment 30. (Metropolitan Edison Co., Reading, Pa.). 22 Sep 1972. 41p. Dep. NTIS.

Requested information is presented concerning the reactor site, engineered safeguards, and the fire suppression system. (D.C.C.)

60675 (DOCKET-50295-64) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 23. (Commonwealth Edison Co., Chicago, Ill.). 1 Oct 1972. 62p. (DOCKET-50304-64). Dep. NTIS.

Revised and additional data are presented concerning engineered safeguards, auxiliary systems, and radioactive waste disposal systems. Layout diagrams of equipment and structures are included. (D.C.C.)

60676 (DOCKET-50295-66) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Safety Evaluation. (Directorate of Licensing (AEC), Washington, D. C.). 6 Oct 1972. 172p. (DOCKET-50304-66). Dep. NTIS.

60677 (DOCKET-50298-54) COOPER NUCLEAR STATION. Supplemental Information Regarding Alternate Discharge System. (Nebraska Public Power District, Columbus). 13 Oct 1972. 1p. Dep. NTIS.

60678 (DOCKET-50302-54) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Notice of Consideration of Issuance of Facility License and Notice of Opportunity for Hearing. (Directorate of Licensing (AEC), Washington, D. C.). 12 Oct 1972. 6p. Dep. NTIS.

60679 (DOCKET-50302-55) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Intended Course of Action With Respect to Three Safety Issues. (Florida Power Corp., St. Petersburg). 9 Oct 1972. 2p. Dep. NTIS.

The intended course of action with respect to three safety issues having the potential to delay operation of the Crystal River Power Reactor, Unit 3, is presented. These safety issues are steam system design, plant protection against flooding, and augmented staffing during plant startup. (H.D.R.)

60680 (DOCKET-50305-53) KEWAUNEE NUCLEAR POWER PLANT. Valve Wall Thickness Verification. (Wisconsin Public Service Corp., Green Bay). 10 Oct 1972. 8p. Dep. NTIS.

60681 (DOCKET-50305-54) KEWAUNEE NUCLEAR POWER PLANT. Loss of Coolant Accidents, Additional Information. (Wisconsin Public Service Corp., Green Bay). 18 Oct 1972. 34p. Dep. NTIS.

60682 (DOCKET-50309-71) MAINE YANKEE ATOMIC POWER STATION. Environmental Studies, Third Annual Report, 1971, Volume 1. (Maine Yankee Atomic Power Co., Westboro, Mass.). Aug 1972. 462p. Dep. NTIS.

60683 (DOCKET-50309-72) MAINE YANKEE ATOMIC POWER STATION. Environmental Studies, Third Annual Report, 1971, Volume 2. (Maine Yankee Atomic Power Co., Westboro, Mass.). Aug 1972. 266p. Dep. NTIS.

60684 (DOCKET-50309-73) MAINE YANKEE ATOMIC POWER STATION. Flooding of Safety Related Equipment. (Maine Yankee Atomic Power Co., Westboro, Mass.). 20 Oct 1972. 2p. Dep. NTIS.

60685 (DOCKET-50312-56) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Oct 1972. 118p. Dep. NTIS.

The environmental effects of construction and operation of the Rancho Seco Power Reactor are examined. The descriptions include: the site; the station; environmental impact of site preparation and site construction; environmental impacts of station operation; environmental impact of postulated accidents; summary discussion of probable adverse effects; short-term uses and long-term productivity; irreversible and irretrievable commitments of resources; need for power; and alternatives to the proposed action and cost-benefit comparison analysis of their environmental effects. (D.C.C.)

60686 (DOCKET-50313-49) ARKANSAS NUCLEAR ONE, UNIT 1. Final Safety Analysis Report, Amendment 28. (Arkansas Power and Light Co., Little Rock). 18 Aug 1972. 1p. Dep. NTIS.

A topographic map is presented for the emergency cooling reservoir of the Arkansas Nuclear One Power Reactor, Unit 1. (H.D.R.)

60687 (DOCKET-50313-53) ARKANSAS NUCLEAR ONE, UNIT 1. Notice of Consideration of Issuance of Facility Operating License and Notice of Opportunity for Hearing. (Directorate of Licensing (AEC), Washington, D. C.). 12 Oct 1972. 7p. Dep. NTIS.

60688 (DOCKET-50313-54) ARKANSAS NUCLEAR ONE, UNIT 1. Environmental Report, Supplement 4. (Arkansas Power and Light Co., Little Rock). 13 Oct 1972. 61p. Dep. NTIS.

60689 (DOCKET-50313-55) ARKANSAS NUCLEAR ONE, UNIT 1. Flooding of Safety Related Equipment. (Arkansas Power and Light Co., Little Rock). 20 Oct 1972. 2p. Dep. NTIS.

60690 (DOCKET-50315-83) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Environmental Statement, Additional Information. (Indiana and Michigan Power Co., New York). 28 Mar 1972. 21p. (DOCKET-50316-83). Dep. NTIS.

Requested information concerning radioactive effluents from the reactors is presented. (D.C.C.)

60691 (DOCKET-50315-86) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Valve Wall Thicknesses Verification, Additional Information. (American Electric Power Service Corp., New York). 12 Oct 1972. 3p. (DOCKET-50316-86). Dep. NTIS.

60692 (DOCKET-50317-61) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Reply to Inquiry Regarding Flood Damage. (Baltimore Gas and Electric Co., Md.). 30 Jun 1972. 1p. (DOCKET-50318-58). Dep. NTIS.

60693 (DOCKET-50317-62) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Action Taken to Correct the Items of Noncompliance Brought to Attention Following Inspection May 31–June 2, 1972. (Directorate of Regulatory Operations (AEC), Newark, N. J. Region I). 22 Sep 1972. 9p. (DOCKET-50318-59). Dep. NTIS.

Information is presented concerning corrections for welding procedures during construction and corrections for the storage of stainless steel pipes. (D.C.C.)

60694 (DOCKET-50321-50) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Final Safety Analysis Report, Amendment 18. (Georgia Power Co., Atlanta). 5 Oct 1972. 133p. Dep. NTIS.

Requested and additional data are presented concerning the reactor site; instrumentation; cooling system; radioactive waste system off gas release limits; and earthquake stress effects on equipment and structures. (D.C.C.)

60695 (DOCKET-50321-51) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Reactor Pressure Vessel Repair. (Georgia Power Co., Atlanta). 9 Oct 1972. 32p. Dep. NTIS.

A repair program is described for the removal of ultrasonic reflectors in the welds of three of the reactor pressure vessel recirculation inlet nozzles on the Hatch Power Reactor, Unit 1. The post-weld heat treatment, ultrasonic examinations of the heat affected areas, a comparison of ultrasonic test results before and after the repair, and post-repair dimensional inspection are presented. (H.D.R.)

60696 (DOCKET-50321-52) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Extensive Prototype Vibration Monitoring Program. (Georgia Power Co., Atlanta). 9 Oct 1972. 2p. Dep. NTIS.

60697 (DOCKET-50321-53) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Final Safety Analysis Report, Amendment 19. (Georgia Power Co., Atlanta). 12 Oct 1972. 64p. Dep. NTIS.

The final safety analysis report for the Edwin I. Hatch Power Reactor, Unit 1 is amended by the submission of requested additional data. (H.D.R.)

60698 (DOCKET-50322-29) SHOREHAM NUCLEAR POWER STATION, UNIT 1. Steps Taken to Correct the Items of Noncompliance Brought to Attention Following Inspection of April 27–28, 1972. (Directorate of Regulatory Operations (AEC), Newark, N. J. Region I). 7 Aug 1972. 9p. Dep. NTIS.

Information is presented concerning the cleaning procedures and quality assurance requirements for pumps with stainless steel parts. (D.C.C.)

60699 (DOCKET-50322-30) SHOREHAM NUCLEAR POWER STATION, UNIT 1. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). 2 Oct 1972. 555p. Dep. NTIS.

The environmental effects of construction and operation of the Shoreham Power Reactor, Unit 1 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (H.D.R.)

60700 (DOCKET-50324-45) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Environmental Report, Amendment 4. (Carolina Power and Light Co., Raleigh, N. C.). 10 Jul 1972. 77p. (DOCKET-50325-46). Dep. NTIS.

Information is presented concerning thermal discharges from the reactors, effects of hurricanes on construction, biological data for the site, and groundwater characteristics of the site. (D.C.C.)

60701 (DOCKET-50324-53) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Volume 8. (Carolina Power and Light Co., Raleigh, N. C.). Apr 1972. 362p. (DOCKET-50325-54). Dep. NTIS.

Information on the Brunswick Power Reactor Units 1 and 2 is presented on the following topics: conformance to AEC criteria; nuclear safety operational analysis; ACRS and AEC staff concerns; inservice inspection program; and pressure vessel design limits. (D.C.C.)

60702 (DOCKET-50324-54) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Volume 9. (Carolina Power and Light Co., Raleigh, N. C.). Apr 1972. 326p. (DOCKET-50325-55). Dep. NTIS.

Information on the Brunswick Power Reactor Units 1 and 2 is presented concerning pipe stresses and rupture. Technical specifications are included. (D.C.C.)

60703 (DOCKET-50324-55) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Volume 10. (Carolina Power and Light Co., Raleigh, N. C.). Apr 1972. 469p. (DOCKET-50325-56). Dep. NTIS.

Additional information is presented concerning radioactive effluents, electrical systems, protection systems, containment system, cooling system, operation aspects, reactor site, and power conversion system. (D.C.C.)

60704 (DOCKET-50324-56) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Volume 11. (Carolina Power and Light Co., Raleigh, N. C.). Apr 1972. 343p. (DOCKET-50325-57). Dep. NTIS.

Additional information is presented concerning the reactor site, containment systems, engineered safeguards, cooling system, operations aspects, instrumentation, radioactive waste disposal systems, auxiliary systems, testing program, power conversion system, safety analysis, and stress limits for equipment and structures. (D.C.C.)

60705 (DOCKET-50324-57) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Steps Taken to Correct the Items of Apparent Noncompliance Brought to Attention in Letter Dated August 16, 1972. (Directorate of Regulatory Operations (AEC), Atlanta, GA. (USA). Region II). 5 Oct 1972. 7p. (DOCKET-50325-58). Dep. NTIS.

60706 (DOCKET-50324-58) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Notice of Receipt of Application for Facility Operating Licenses. (Directorate of Licensing (AEC), Washington, D. C.). 13 Oct 1972. 3p. (DOCKET-50325-59). Dep. NTIS.

60707 (DOCKET-50324-59) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Fracture Toughness of Brunswick Pressure Vessels. (Carolina Power and Light Co., Raleigh, N. C.). 18 Oct 1972. 3p. (DOCKET-50325-60). Dep. NTIS.

60708 (DOCKET-50327-28) SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Environmental Radioactivity Levels, Semiannual Report, August 1971–January 1972. (Tennessee Valley Authority, Chattanooga. Div. of Environmental Research and Development). 1972. 37p. (DOCKET-50328-26). Dep. NTIS.

60709 (DOCKET-50331-57) DUANE ARNOLD ENERGY CENTER. Environmental Report, Amendment 2, Revised. (Iowa Electric Light and Power Co., Cedar Rapids). Oct 1972. 201p. Dep. NTIS.

Requested information is presented concerning transmission lines, site, circulating water system, and chemical effluents. (D.C.C.)

60710 (DOCKET-50331-58) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Amendment 6. (Iowa Electric Light and Power Co., Cedar Rapids). 6 Oct 1972. 60p. Dep. NTIS.

The final safety analysis report for the Duane Arnold Power

Reactor is amended by the submission of requested additional information on radioactive waste systems. (H.D.R.)

60711 (DOCKET-50333-55) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Final Safety Analysis Report, Supplement 12. (Power Authority of the State of New York). 25 Sep 1972. 84p. Dep. NTIS.

Information on the James A. Fitzpatrick Power Reactor is presented concerning the cooling system, instrumentation, electrical systems, radioactive effluents, and earthquake stress limits for equipment and structures. (D.C.C.)

60712 (DOCKET-50333-56) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Action Taken to Correct the Items of Nonconformance Brought to Attention Following March 20-23, 1972 Inspection. (Directorate of Regulatory Operations (AEC), Newark, N. J. Region I). 22 Jun 1972. 10p. Dep. NTIS.

Information is presented concerning corrections to quality assurance procedures for construction. (D.C.C.)

60713 (DOCKET-50333-57) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Action Taken to Correct the Items of Noncompliance Brought to Attention Following Inspection on June 20-23, 1972. (Directorate of Regulatory Operations (AEC), Newark, N. J. Region I). 8 Sep 1972. 7p. Dep. NTIS.

Information is presented concerning welding and inspection procedures for cooling system piping, inspection and quality assurance requirements for valves in the cooling system and main steam system, and identification marks used on Class 1 piping. (D.C.C.)

60714 (DOCKET-50333-59) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Final Safety Analysis Report, Supplement 13. (Power Authority of the State of New York). 16 Oct 1972. 76p. Dep. NTIS.

The final safety analysis report for the James A. Fitzpatrick Power Reactor is amended by the submission of revised and additional information. (H.D.R.)

60715 (DOCKET-50334-34) BEAVER VALLEY POWER STATION, UNIT 1. Reply to Inquiry on Possible Flood Damage. (Duquesne Light Co., Pittsburgh, Pa.). 30 Jun 1972. 1p. Dep. NTIS.

60716 (DOCKET-50334-35) BEAVER VALLEY POWER STATION, UNIT 1. Flooding of Safety Related Equipment. (Duquesne Light Co., Pittsburgh, Pa.). 25 Oct 1972. 1p. Dep. NTIS.

60717 (DOCKET-50334-36) BEAVER VALLEY POWER STATION, UNIT 1. Final Safety Analysis Report, Volume 1. (Duquesne Light Co., Pittsburgh, Pa.). 27 Oct 1972. 491p. Dep. NTIS.

Information on the Beaver Valley Power Reactor Unit 1 is presented concerning the reactor site. (D.C.C.)

60718 (DOCKET-50334-42) BEAVER VALLEY POWER STATION, UNIT 1. Final Safety Analysis Report, Volume 7. (Duquesne Light Co., Pittsburgh, Pa.). 27 Oct 1972. 418p. Dep. NTIS.

Information on the Beaver Valley Power Reactor Unit 1 is presented concerning the safety analysis. (D.C.C.)

60719 (DOCKET-50336-45) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 2. Final Safety Analysis Report, Amendment 14. (Millstone Point Co., Hartford, Conn.). 16 Oct 1972. 316p. Dep. NTIS.

Revised and additional data are presented concerning safety analysis, personnel qualifications, auxiliary systems, electrical systems, protection systems, engineered safeguards, cooling system, and operations aspects. (D.C.C.)

60720 (DOCKET-50338-52) NORTH ANNA POWER STATION, UNITS 1 AND 2. Construction Permits CPPR-77 and CPPR-78, Amendment 2, Issued. (Directorate of Licensing (AEC), Washington, D. C.). 17 Oct 1972. 4p. (DOCKET-50339-49). Dep. NTIS.

60721 (DOCKET-50344-32) TROJAN NUCLEAR PLANT. Construction Permit CPPR-79, Amendment 1 Issued. (Directorate of Licensing (AEC), Washington, D. C.). 17 Oct 1972. 3p. Dep. NTIS.

60722 (DOCKET-50352-29) LIMERICK GENERATING STATION, UNITS 1 AND 2. No Damage as Result of Flood. (Philadelphia Electric Co., Pa.). 6 Jul 1972. 1p. (DOCKET-50353-29). Dep. NTIS.

60723 (DOCKET-50361-28) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Amendment 16. (Southern California Edison Co., Rosemead, Calif.). 12 Oct 1972. 556p. (DOCKET-50362-27). Dep. NTIS.

The preliminary safety analysis report for the San Onofre Power Reactor, Units 2 and 3 is amended by the submission of revised and additional information in responses to AEC questions. (H.D.R.)

60724 (DOCKET-50363-40) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Oct 1972. 175p. Dep. NTIS.

The environmental effects of construction and operation of the Forked River Power Reactor, Unit 1 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (H.D.R.)

60725 (DOCKET-50368-35) ARKANSAS NUCLEAR ONE, UNIT 2. Flooding of Safety Related Equipment. (Arkansas Power and Light Co., Little Rock). 20 Oct 1972. 2p. Dep. NTIS.

60726 (DOCKET-50382-39) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Changes in Design to Discharge. (Louisiana Power and Light Co., New Orleans). 11 Oct 1972. 2p. Dep. NTIS.

60727 (DOCKET-50387-24) SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2. Reply to Inquiry Regarding Flooding of June 27, 1972. (Pennsylvania Power and Light Co., Allentown). 29 Jun 1972. 2p. (DOCKET-50388-24). Dep. NTIS.

60728 (DOCKET-50409-17) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report for July 1972. (Dairyland Power Cooperative, La Crosse, Wis.). Jul 1972. Contract AT(11-1)-851. 29p. (DPC-851-45). Dep. NTIS.

60729 (DOCKET-50409-18) LA CROSSE BOILING WATER REACTOR. Flooding of Critical Equipment. (Dairyland Power Cooperative, La Crosse, Wis.). 28 Sep 1972. 2p. Dep. NTIS.

60730 (GULF-GA-B-10872) FORT ST. VRAIN HTGR MAXIMUM ROD WORTH AND ROD WITHDRAWAL ACCIDENT CALCULATIONS FOR REACTOR THERMAL POWERS FROM 2 PERCENT TO 100 PERCENT. Brown, J. R.; Nirschl, R. J. (Gulf General Atomic Co., San Diego, Calif.). 3 Jul 1972. Contract AT(04-3)-633. 92p. Dep. NTIS.

The maximum-expected worth control rod pair has been calculated for a variety of reactor conditions including beginning of initial cycle and operating power levels from 2% to 100%. The calculated maximum worth rod pair in a specified rod withdrawal sequence is a function of the excess reactivity being held in inserted control rods. For low power operation where the core temperature is reduced, more control rods are inserted and the calculated-maximum rod pair worth increases. For reactor operations below full power and/or with temperature coefficients more negative than end-of-cycle conditions (as with beginning-of-cycle), the accidental withdrawal of a rod pair with a worth greater than 0.012 $\Delta\rho$ leads to consequences no more severe than described in the FSAR, since there is more negative reactivity compensation available from the more negative temperature coefficient and/or from the lower initial core temperature. The results of a series of transient analyses are presented which provide the basis for determining the maximum-allowable rod pair worth under a variety of reactor operation conditions, which, in an accidental rod withdrawal accident would lead to consequences no more severe than the 0.012 $\Delta\rho$ rod withdrawal from full power end-of-equilibrium cycle conditions analyzed in the FSAR. In all cases the maximum-allowable rod pair worth is greater than the maximum-expected rod pair worth for a given operation condition.

60731 (NP-19378) ANNUAL REPORT, 1971. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). 97p. (In German). Dep. NTIS (U. S. Sales Only).

The 1971 Annual Report of the Institute for Reactor Safety is presented. After a summary of the organization and administration of the Institute, the concept of reactor safety is discussed. Approval procedures for projected and new reactors were given.

The function of the Reactor Safety Commission is described. The research projects on reactor safety are tabulated. The work of the principal sections is indicated. The publications of the Institute are listed. (J.S.R.)

60732 (NP-19422) INFLUENCE OF METEOROLOGICAL FACTORS ON POSSIBLE CONTAMINATION FROM A NUCLEAR POWER PLANT AT SILIVRI-KULA CREEK. Erkmen, M. Melih (Cekmece Nuclear Research and Training Center, Istanbul (Turkey)). 1972. 24p. Dep. NTIS (U. S. Sales Only).

The influence of meteorological factors on possible radioactive contamination from the proposed nuclear power plant at Silivri-Kula Creek has been studied, and the problems associated with temperature inversions, wind flow, and precipitation in the vicinity of the plant site have been discussed in detail. The analysis of meteorological factors in the vicinity of the proposed reactor site has provided a detailed picture of the expected incidence and likely persistence of weather conditions which would be most or least favorable for the dispersion or concentration of airborne contaminants, as well as the speed and direction in which they might be carried from the source to the surrounding area. The results for average frequency of prevailing surface winds, surface winds during inversions, and number of occurrences of precipitation at time of inversions have been presented in the form of tables. The study shows that during times of inversions surface winds blow from the southwest for a significant part of the time. This wind flow favors removal of contaminants to areas of low population. Furthermore, critical inversion conditions occur infrequently and are seldom accompanied by rainfall which could result in maximum concentrations of pollution at the ground surface. 16 references. (auth)

60733 (NYO-4260(Pt.1 and 2)) USE OF THE CHESAPEAKE BAY FOR COOLING THERMAL-ELECTRIC POWER PLANTS. PART I. RESEARCH PRIORITIES. PART II. STATUS OF INFORMATION ABOUT THE CHESAPEAKE BAY AND SHORELINE. Wolman, M. Gordon; Meyers, Caldwell D.; Flynn, Charles R.; Sheer, Daniel P. (Johns Hopkins Univ., Baltimore, Md. (USA). Dept. of Geography and Environmental Engineering). May 1972. 67p. Dep. NTIS.

A review of information about the Chesapeake Bay and shoreline provides the basis for an evaluation of research priorities. These priorities in biological research include quantitative information on the life cycle and distribution of important organisms, entrainment effects on organisms, the effects on organisms of discharge plumes of heated water, effects of biocides on organisms, a spatial classification of ecological environments of the Chesapeake Bay, and analysis of variability and statistical control of biological sampling and research programs. (141 references) (auth)

60734 (TID-26167) GUIDE FOR SUBMISSION OF INFORMATION ON COSTS AND BENEFITS OF ENVIRONMENTALLY RELATED ALTERNATIVE DESIGNS FOR DEFINED CLASSES OF COMPLETED AND PARTIALLY COMPLETED NUCLEAR FACILITIES. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.). May 1972. 47p. Dep. NTIS.

Explanations of legal requirements and citations for them are given. Sample formats for submission of reports are included. (J.M.J.)

60735 NUCLEAR PLANT SAFETY. Baskin, K. P. pp V.1-100 of Environment. Los Angeles; Southern California Edison Co. (1971).

Fundamental principles of reactor safety are presented. Safeguards against accidents both inherent and engineered, are described. Engineered safety features are discussed. Operational safety is treated generally. Radiation hazards during normal operation are considered. (J.M.J.)

60736 SITING OF NUCLEAR POWER PLANTS. Storeboe, P. Fossekallen; 18: No. 6, 16-18(Dec 1971). (In Norwegian).

A brief treatment of the background for the introduction of nuclear power on the Norwegian grid around 1980 is followed by a short survey of the main factors affecting the choice of site. The first power station will be built in the Oslofjord area. The study has taken place over two years, carried out by four groups whose respective tasks have been economic aspects, hydrological aspects (cooling water recipient), safety aspects and regional planning aspects. In the course of 1972 it is hoped to reduce the choice from about 20 to 5-6 prospective sites. Similar studies will be carried out for other regions. (J.I.W.)

Steam and Power Conversion System

60737 (FRNC-CONF-50) DIGITAL SIMULATION OF WATER SUPPLY SYSTEMS. Bai, J. P.; Poizat, F.; Sureau, H. (Electricite de France, Paris). 1972. 9p. (In French). (CONF-720648-3). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

A digital model which simulates the dynamic performance of thermal and nuclear power plant water supply systems is described. The temporary isolation of the Fessenheim I PWR plant is discussed as a typical application of the model. This type of simulation model is very useful for a number of design applications, e.g., for general layout design, the dimensioning of tanks, pumps, balance pipe and venting systems, and for investigations on heat loads and on mutual interactions between the boiler and the turbine. (auth)

60738 INVESTIGATION INTO THE CONSEQUENCES OF THE FAILURE OF A TURBINE-GENERATOR AT HINKLEY POINT A POWER STATION. Gray, J. L. (Central Electricity Generating Board, Cheltenham, Eng.). Proc. Inst. Mech. Eng. (London); 186: No. 32, 379-90(1972).

There were three main areas of investigation into the Hinkley Point "A" turbine-generator failure: laboratory and on-site exploration of conditions for stress corrosion cracking of relevant steels, a survey of all relevant rotors to explore the effects of applying a purely fracture mechanics approach in ignorance of the mechanism causing the initial crack or defect, and an examination of rotors withdrawn from machines of similar mechanical design and of properties deemed to be in the highest risk category. Interim conclusions suggest that in certain non-reheat turbines it is possible to generate high chemical concentrations in regions of high stress and thus to promote stress corrosion cracking. The rate of propagation of such cracks is sufficient to produce critical stress intensities in discs of low fracture toughness in a region of high stress concentration. (auth)

60739 STEAM TURBINE FAILURE AT HINKLEY POINT A. Kalderon, D. (General Electric Co. Ltd., Rugby, Eng.). Proc. Inst. Mech. Eng. (London); 186: No. 31, 341-77(1972).

The catastrophic failure of Hinkley Point "A" unit No. 5 steam turbine in September 1969 was the result of spontaneous brittle fracture of a shrunken l.p. turbine disc, initiated by stress-corrosion cracking in the crown of a keyway in the disc bore. Stress corrosion cracking of disc bores and keyways was also found on a number of other discs. The discs were made of 3 Cr—Mo steel and complied with normal acceptance standards, but owing to temper embrittlement, their fracture toughness was low, and cracks only about $^{1}/_{16}$ in. deep in the concentrated stress field at the keyway crown were large enough to initiate brittle fracture. (auth)

Propulsion and Auxiliary Power Reactors

Refer also to abstract 58715.

60740 (AI-AEC-13032) SNAP REACTOR PROGRAMS PROGRESS REPORT, FEBRUARY-APRIL 1972. (Atomics International, Canoga Park, Calif.). 15 Aug 1972. Contract AT(04-3)-701. 108p. Dep. NTIS.

Although Incoloy 800 is easier to machine, more ductile, and has better long-term thermal stability, Hastelloy X was selected, because of its superior strength, as the reference fuel element cladding material for the current generation of ZrH reactors. Test work to determine the stress distribution resulting from fuel bearing on the cladding wall was completed. A mathematical model was prepared so that these results could be applied to fuel elements of different diameters. Coolant mixing tests for the right-left-neutral fuel element array were completed and the data evaluated. Conceptual design of the reactor for the 5-kW(e) system was initiated. Although the reactor design point is a function of the system design point selected, its thermal power requirement is approximately 100 kW(t) at a reactor outlet temperature of 1200°F for 5 years. A ball screw, with a translating nut, was selected as the reference technique for the reflector segment drive. Test fixtures have been designed to test the ball screw mechanism to temperatures of 1000°F and 10^{-6} torr vacuum at design loads. Satisfactory SCB-coated butt welds were obtained on Hastelloy X fuel element cladding. In addition, helical fins were machined in 19 Hastelloy X cladding tubes by hobbing. Vibration and permeation tests indicate that fuel elements are unaffected by loads resulting from a Saturn V or Titan III-C launch. Hastelloy X cladding property testing continued. Reactor power modules continue to operate with degradation rates ranging from 1.0 to 3.5% per 10,000 hours for operating times to 3500 hours, temperatures to 1140°F (average), and up to 58 thermal cycles per module. (auth)

60741 (LA-DC-72-1078) MONTE CARLO DEVELOPMENT AND APPLICATIONS IN THE LOS ALAMOS NUCLEAR ROCKET PROGRAM. Watson, Clayton W.; Cashwell, Edmond D. (Los Alamos Scientific Lab., N. Mex.). 1972. 45p. (CONF-721018-6). Dep. NTIS.

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

The history of Monte Carlo use in the Rover Nuclear rocket program at LASL is traced. The type of problems requiring Monte Carlo solutions and specific applications are discussed, the latter to show how need led to development and to illustrate capabilities. A synopsis of present codes, code characteristics, and available tally options is included. Of principal interest have been radiation environmental calculations for the Rover reactor-testing program. Recent emphasis, however, has been upon Monte Carlo criticality calculations. Data from experimental studies conducted explicitly to assess Monte Carlo results are presented and discussed. Monte Carlo criticality results are also compared with experiment. Finally, plans for the extension of Monte Carlo capabilities are outlined. 44 references. (auth)

60742 AIRCRAFT NUCLEAR PROPULSION: A NEW LOOK IN 1971. Mills III, King Louis. Charlottesville, Va.; Univ. of Virginia (1972). 275p. University Microfilms Order No. 72-22,653.

Thesis.

The design of a nuclear propulsion system for large aircraft is presented. Primary interest is on achieving an accurate description of the reactor core and reflector. Power tailoring is used to reduce the radial peak-to-average ratio to 1.1 or less throughout the core. Basic heat transfer equations are used to obtain axial and radial temperature distributions in a fuel "pin." Shield configurations and weights are based on U.S. Atomic Energy Commission standards for occupational exposure because the aircraft design is military rather than commercial. Reactor power requirements are based on energy equivalents: the thermal energy from the core equals the energy input from jet fuel at the flight design conditions. Estimates of heat and pressure losses through the reactor coolant system are made. Temperature changes across both sides of the heat exchanger are determined for system operating conditions. The consequences of a major aircraft accident are considered and the penalties to reduce or prevent them are determined. Full containment of fission products seems possible for most conceivable accidents. The overall system is analyzed and compared to other proposed systems. All calculations for shielding and safety are designed to give conservative answers and to provide a margin of safety. (Diss. Abstr. Int., B)

60743 CRITICALITY TEST FACILITY ON LAND OF NUCLEAR SHIP MUTSU. Shimooke, Takanori; Yamada, Nobuyuki (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen; No. 96, 2389-2402(Oct 1971). (In Japanese).

Criticality experiment on land for "Mutsu" is performed as a mockup test with a shore facility. A description of the mockup facility is presented. (Japan)

Process Heat and Desalination Reactors

60744 (JUL-870-RG) GENERATION OF PROCESS STEAM BY HIGH-TEMPERATURE REACTORS. Kugeler, Kurt (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Jun 1972. 46p. (In German). Dep. NTIS (U. S. Sales Only).

A reactor power plant is described for the production of process steam and for the electricity generation by a counter pressure turbine, and explained by general drawings and data lists. Particular emphasis is placed to naval reactor designs. (auth)

Research and Test Reactors

Refer also to abstracts 60521, 60523–60525, and 60585.

60745 (CONF-721018-1) ORNL BENCHMARK EXPERIMENT FOR NEUTRON TRANSPORT IN THICK SODIUM. Maerker, R. E.; Muckenthaler, F. J.; Clifford, C. E. (Oak Ridge National Lab., Tenn.). 1972. 18p. Dep. NTIS.

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

The description of an experiment performed at the Tower Shielding Facility (TSF) is presented which provides verification of cross-section accuracy for use in transport calculation of deep penetration of neutrons through 15 ft of sodium. Results of calculations of the experiment are presented which were obtained by using the MORSE multigroup Monte Carlo code to calculate the transport based on an early version of the ENDF/B-III cross-section set for sodium. Comparison of the calculations with experiment indicates that the total neutron leakage above thermal energies penetrating 15 ft of sodium can be calculated to within ~30% and neutrons penetrating up to 10 ft of sodium to within ~10%. 11 references. (auth)

60746 (JEN-225-DINE/I-1) HYDRAULIC AND THERMAL CHARACTERISTICS OF THE REACTOR JEN-1. Oltra Oltra, F.; Leira Rey, G. (Junta de Energia Nuclear, Madrid (Spain). Division de Ingenieria Nuclear y Electronica). 1971. 54p. (In Spanish). Dep. NTIS (U. S. Sales Only).

An analysis is made of the thermal and hydraulic performances of the JEN-1 reactor operating steadily at 3 MW of thermal power. The analysis is made separately for the core, main heat exchanger and cooling tower. The performances of these three main components at a power higher than the maximum 3 MW attainable at present are calculated. A study is made of the unsteady operation of the reactor, focusing the attention towards the pumping characteristics and the temperatures obtained in the fuel elements. Reference is made to several digital calculation programs that have been developed for such purposes. (21 references) (auth)

60747 (JINR-P3-6556) YIELD OF ULTRA-COLD NEUTRONS FROM A MODERATOR. Golikov, V. V.; Lushchikov, V. I.; Shapiro, F. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1972. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

The yields of ultracold neutrons from various thin plastic converters were computed, wherein the converters had a temperature T_k and were irradiated by an isotropic thermal neutron flux with a Maxwellian spectrum of temperature T_H. The removal of very slow neutrons from the thin surface layer of the moderator could be limited by cooling this surface layer or the converter, but not the entire moderator. Experimental verification of the calculations was conducted in an ultracold neutron canal of the pulsed reactor IBP-30. (12 references) (tr-auth)

60748 (LFEN-NI-71-a) STUDY OF THE DISTRIBUTION OF THERMAL NEUTRON FLUX IN THE CORE AND DETERMINATION OF THE RPI POTENTIAL BY SCANNING OF WIRES. Ramalho, Antonio J. G.; de Lima, Adriano J. R. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1971. 39p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

The results obtained in the application of the wire scanning technique to the study of the present configuration of the RPI core were reported. The distribution of the thermal flux in the core is presented and the consumption factors of the fuel elements and the reactor power were determined. It is shown that with this method the reactor power can be determined with an error of 1.5%. The simplicity of the method and the rapidity of its application are emphasized and some aspects that can be improved are examined. (tr-auth)

60749 NEUTRON-SELECTOR PHASE STABILIZER. Orban, D.; Slavik, F. (Central Inst. of Physics Research, Budapest). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 44-8 (1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 48-52(1972).

A semiconductor device for stabilizing the phase of a rotating neutron selector is described, which allows the phase of the selector to be stabilized with an accuracy $\sim 4 \cdot 10^{-4}$ relative to the position of the rotating disk of the pulsed reactor at the Joint Institute of Nuclear Research. A block diagram of the device is given, and its individual sections are described. (auth)

60750 OWL-2 INPILE LOOP FOR JAPAN MATERIAL TESTING REACTOR OF ATOMIC ENERGY RESEARCH INSTITUTE. 2. Ishikawajima-Harima Giho; 12: No. 4, 422-31(Jul 1972). (In Japanese).

The test facility, OWL-2, is the largest nuclear fuel irradiation test facility for JMTR. This facility is the first to have a thru-type inpile test section among the irradiation test facilities in Japan. The installation work of the inpile tube under a high radiation level and the commissioning test results are presented. (auth)

60751 DEVELOPMENT OF A DIGITAL CONTROL PROGRAM FOR A NUCLEAR FAST REACTOR BY A HYBRID COMPUTER. Ciriegi, U. (CNEN, Bologna); Rimini, B.; Turrini, E. pp 442-54 of Conference on Hybrid Computation. Brussels; Presses Academiques Europeenes (1970).

From sixth conference on hybrid computation; Munich, Germany (31 Aug 1970). See CONF-700826.

Development of a program for a hybrid-computer for on-line control of a fast reactor is described. (J.M.J.)

60752 OPERATION OF NATURAL COOLING AT THE TRAINING REACTOR OF THE BUDAPEST TECHNICAL UNIVERSITY. Szondi, Egon. Energ. Atomtech.; 24: No. 4, 175-83(Apr 1971). (In Hungarian).

The built-in reactivity in the training reactor is about 0.7 S. The reactor has a negative temperature factor, so the reactivity excess decreases at an operation temperature of 55 to 60°C to zero. The construction of the cooling system determines the output achievable at this temperature and proportionately the neutron flux governing the searching conditions too. The reactor has a reservoir construction; its cooling can be fulfilled either by forced circulation or by natural circulation. For the calculation of natural circulation conditions low-temperature differences and small dimensions must be taken into account, which may be disregarded for power reactors. (auth)

Production Reactors

Refer also to abstract 59237.

Reactor Components, Fuels, and Accessories

Refer also to abstracts 59154, 59184, 59222, 59233, 59235, 59238, and 59257.

60753 (BNWL-CC-2445) PROPOSAL TO IRRADIATE INTENTIONALLY DEFECTED MIXED-OXIDE FUEL RODS IN THE ETR M-3 LOOP FACILITY. THE 23 kW/ft TEST SERIES: (BNW-5-1 THROUGH -6). Hann, C. R.; Burley, T. B.; Freshley, M. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 10 Feb 1970. 73p. Dep. NTIS.

The purpose of the proposed tests is to evaluate the defect behavior of Zircaloy-clad mixed-oxide pellet-containing fuels and possibly establish fuel performance limits. The results are directly related to the objectives and needs of the Plutonium Utilization Program (PUP). (auth)

60754 FAST AUTOMATIC TRANSPORT SYSTEM FOR STUDYING SHORT-LIVED NUCLEAR STATES IN THE MILLISECOND RANGE. Brandstaedter, O.; Girsig, F.; Grass, F.; Klenk, R. (Oesterreichische Hochschule, Vienna). Nucl. Instrum. Methods; 104: No. 1, 45-53(1972). (In German).

A detailed description of the hitherto fastest pneumatic tube system is given; transfer time using compressed nitrogen or helium is only 20 ms or 15 ms, respectively, to transport the sample. The mechanical construction and the necessary specifications of the electronic controlling unit are outlined. The results of 12 more accurate half-life determinations of isomeric transitions in the range 17 to 809 ms are presented. (8 figures, 1 table) (auth)

60755 AUTOMATIC IRRADIATION APPARATUS WITH ON-LINE MEASUREMENT SYSTEM FOR THE STUDY OF SHORT-LIVED ACTIVITIES. Okano, K.; Nakagome, Y.; Kawase, Y.; (and others) (Kyoto Univ.). Nucl. Instrum. Methods; 104: No. 1, 13-19(11972).

For the study of short-lived activities produced by (n,γ) reactions, a spherical pneumatic irradiation apparatus with on-line measurement system was designed and installed at the through-tube facility of the Kyoto University reactor. With this apparatus the irradiation of a sample and the subsequent nuclear spectroscopic measurements are automatically and cyclically performed. By means of this apparatus, singles and coincidence spectra of γ rays, angular correlations of cascading transitions, or lifetimes of excited states were measured for several short-lived isotopes. A detailed description of the apparatus and some of the results obtained are presented. (9 figures) (auth)

60756 EDUCATION AND RESEARCH IN THE NUCLEAR FUEL CYCLE. Conference Held at Norman, Oklahoma, October 5–7, 1970. Elliott, David M.; Weaver, Lynn E. (eds.). Norman, Okla.; University of Oklahoma Press (1972). 342p. $9.95. (CONF-701035).

Separate abstracts have been prepared for 16 of the 18 papers; two papers were previously abstracted in NSA. (J.M.J.)

For abstracts of individual papers see: 59183, 59323, 59353, 59362, 58776, 58777, 58953, 60578–60580, 60584, 60602–60605, and 60628.

Reactor Physics and Core Engineering

Physics

60757 (AEEW-R-782) APPLICATION OF FIRST-ORDER PERTURBATION THEORY TO THE CALCULATION OF FUEL TEMPERATURE COEFFICIENTS. Siudek, R. S. (Atomic Energy Establishment, Winfrith (England)). Aug 1971. 20p. Dep. NTIS (U. S. Sales Only).

The application of first-order perturbation theory to the calculation of fuel temperature coefficients is considered. A comparison is made between the results obtained using this theory, and those obtained from conventional calculations of fuel temperature coefficients. The flexibility of the perturbation method has allowed the effects of various changes and assumptions in the physical model to be investigated, for a very small amount of additional computer time. 8 references. (auth)

60758 (AEEW-R-797) ASSESSMENT OF METHODS AND DATA FOR PREDICTING INTEGRAL PROPERTIES FOR THERMAL REACTOR PHYSICS EXPERIMENTS. Chawla, R. (Atomic Energy Establishment, Winfrith (England)). May 1972. 49p. Dep. NTIS (U. S. Sales Only). UK 1.00 pound.

The performance of "best" available theoretical methods and differential nuclear data for predicting integral thermal reactor properties, such as reactivity and reaction rate ratios, is assessed in the light of evidence from a broad range of clean, benchmark experiments. It is shown that for improving the consistency of calculated integral parameters for D_2O, H_2O and graphite moderated systems, significant modifications to certain currently used nuclear data are desirable. Along with changes in moderator scattering cross-sections, ^{238}U resonance data and the ^{235}U fission energy spectrum, some modification of ^{235}U thermal data has been made which lies within the experimental uncertainties of differential measurements. The "new" data options have been used in various analyses with the WIMS lattice code, and results are presented for the benchmark studies and also for some lattices with more complicated geometries. It is shown that the preferred data generally gives more consistent results for both reactivities and reaction rates over a wide range of conditions, than any previously considered data combinations. For power reactor conditions, however, there is some evidence that the preferred data may overestimate conversion ratio. (49 references) (auth)

60759 (CEA-R-2488) INTERPRETATION OF CRITICALITY EXPERIMENTS ON HOMOGENEOUS SOLUTIONS OF PLUTONIUM AND URANIUM. Ithurralde, Marie-France; Kremser, Jacques; Leclerc, Jean; Lombard, Christiane; Moreau, Jean; Robin, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1964. 37p. (In French). Dep. NTIS (U. S. Sales Only).

Criticality experiments on solutions of fissionable materials have been carried out in tanks of various geometries (cylinder, isolated annular cylinder, interacting annular cylinders); the reflection conditions have also been varied (without reflection, semi-reflection and total reflection by water). The range of the studied concentrations is rather large (18.8 to 104 gms/liter). The interpretation of these experiments has been undertaken in order to resolve the problems of the industrial use of homogeneous plutonium and uranium solutions. Several methods have been used: diffusion method, transport method and Monte-Carlo method. (10 references) (auth)

60760 (COO-3052-6) PROGRESS REPORT NO. 18, 15 MARCH 1972–15 JUNE 1972. Hansen, K. F.; Henry, A. F. ([Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering]). 1972. Contract AT(11-1)-3052. 4p. Dep. NTIS.

A cell stitching procedure for determining detailed neutron flux shapes throughout a reactor is applied to two-dimensional x, y geometry. The major effort is concerned with accounting for the discontinuous behavior of the flux at points between two cells of different composition. (H.D.R.)

60761 (LA-4941) LINKAGE OF REACTOR PHYSICS CODES THROUGH STANDARD INTERFACES. Carmichael, B. M.; Vigil, J. C. (Los Alamos Scientific Lab., N. Mex.). Aug 1972. Contract W-7405-eng-36. 96p. Dep. NTIS.

Selected reactor physics codes have been linked by a set of interface files. Access to codes, free-format card input for creating or modifying the files, system-restart capability, and file-printing options are all available at any point in whatever calculation path the user chooses to prescribe. (19 references) (auth)

60762 (RT/FI–(72)17) NUCLEAR GUESSWORK: THE EQUATION OF CHAPMAN–KOLMOGOROV FOR MULTIPLYING SYSTEMS Jorio, V. M.; Rovelli, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 19 May 1972. 67p. (In Italian). Dep. NTIS (U. S. Sales Only).

The information presented includes: theory of branching processes in multiplying systems; Kolmogorov's "forward" and "backward" equations; the Fokker–Plank equation for a monoenergetic zero-dimensional reactor model with no delayed neutrons; integration of the Fokker–Plank equation according to the Babala's approximation; efforts of integration via higher-order approximations; and criticism and limits of approximated solutions. 8 references. (auth)

60763 (Y-DR–91) CALCULATED CRITICAL MASS FOR SPHERES OF $^{233}UO_2$–H_2O MIXTURES FOR NUCLEAR CRITICALITY SAFETY EVALUATIONS. Magnuson, D. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 29 Sep 1972. Contract W-7405-eng-26. 7p. Dep. NTIS.

In the absence of experimental criticality data, calculations of critical masses of spheres, which contain ^{233}U as metal or oxide–water mixtures and which are unreflected or reflected by H_2O or 2 in. of lead, have been made at full density and at reduced density. (auth)

Core Thermal Hydraulics

60764 MINIMIZING THE RADIAL TEMPERATURE DROP IN CYLINDRICAL DISPERSE FUEL ELEMENTS. Milovanov, Yu. V.; Abramyan, R. I. This paper was summarized in At. Energ. (USSR); 31: No. 2, 135-6(Aug 1971) as paper No. 513/6236. (In Russian).

Full copy of this paper is held by TIC.

Minimization of the radial temperature drop ΔT in a disperse fuel element requires solution of the variational problem for the radial distribution of the fuel concentration in the element for the minimum ΔT (the fuel concentration $\bar{c}$ averaged over the cross section, the diameter of the element, and its thermal power must remain constant). This problem is solved for the particular case of a stepped concentration distribution in which the fuel element is divided into two concentric zones (an inner one and an outer one) having different volume concentrations of fuel, c_1 and c_2, respectively, constant within each zone. 4 references. (auth)

GENERAL

Civilian Defense

60765 (ARH-SA-132) AEC DECLASSIFICATION PROGRAM. Barber, A. E. (Atlantic Richfield Hanford Co., Richland, Wash.). 13 Jun 1972. Contract AT(45-1)-2130. 9p. (CONF-720712-2). Dep. NTIS.

From National Classification Management Society seminar; Palo Alto, CA. (19 Jul 1972).

Topics include classification guidance, applying the guidance for declassification, role of the Coordinating Organization Director, and notification and marketing. (W.H.K.)

Law

60766 (AECL-4306) APEX FOR THE G-20/3300 COMPUTER SYSTEM. PART B. Okazaki, E. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1972. 95p. Dep. NTIS (U. S. Sales Only). AECL $2.00.

Part A (AECL-4307) and Part B of this two-part APEX manual supersede the earlier APEX-IV manual (AECL-1978). Part B replaces those sections which dealt with input and output for the G-20/3300 computer system. Hints for programming in APEX, and descriptions of library procedures and programs which are related to the subjects covered, are also included. (auth)

60767 (AECL-4307) APEX FOR THE G-20/3300 COMPUTER SYSTEM. PART A. McPherson, D.; Okazaki, E. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1972. 49p. Dep. NTIS (U. S. Sales Only).

Those sections of the APEX-IV manual (AECL-1978) which describe the syntax and semantics of APEX programming language were revised. This description, with accompanying examples, replaces AECL-1978 as a programmer's guide to APEX. Detailed description of input and output facilities are contained in Part B (AECL-4306). (auth)

60768 NUCLEAR LEGISLATION. ANALYTICAL STUDY. Regulations Governing Nuclear Installations and Radiation Protection. Paris; Organisation for Economic Co-operation and Development (1972). 494p.

The regulations governing nuclear installations and radiation protection in countries that were members of the Organization for Economic Cooperation and Development on June 1, 1972 are presented. The member countries include Austria, Belgium, Canada, Denmark, Finland, France, Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States. The plan of study presented for each country includes: fundamental radiation protection legislation; system of authorization and control of nuclear installations; system of authorization and control of radioactive materials; protection of the public; and protection of workers. (E.R.B.)

Miscellaneous

60769 (ACRH-1000-370) RECRUITMENT OF MEDICAL PHYSICISTS IN THE UNITED STATES. Lanzl, Lawrence H. (Chicago Univ., Ill.). 1972. 7p. (CONF-720435-6). Dep. NTIS.

From Seminar on training and education in medical physics; Kiel, Germany (10 Apr 1972).

60770 (AECL-3415) LSF: AN INTERPRETER FOR A CLASS OF LEAST SQUARES FITTING PROBLEMS. McPherson, D.; Johnson, J. H. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1972. 53p. Dep. NTIS (U. S. Sales Only). AECL $1.50.

60771 (BDX-613-485(Rev.)) MATERIAL AND PROCESS DEVELOPMENT OF POLYURETHANE FOAM, FY71-4. Quarterly Report. Fender, J. R. (Bendix Corp., Kansas City, Mo.). Sep 1972. Contract AT(29-1)-613. 50p. Dep. NTIS.

60772 (BDX-613-493(Rev.)) DEVELOPMENT OF ELASTOMER CUSHIONS, FY71-4. Quarterly Report. Edman IV, G. W. (Bendix Corp., Kansas City, Mo.). Sep 1972. Contract AT(29-1)-613. 15p. Dep. NTIS.

60773 (BDX-613-553(Rev.)) MATERIAL AND PROCESS DEVELOPMENT OF POLYURETHANE FOAM, FY72-1. Quarterly Report. Fender, J. R. (Bendix Corp., Kansas City, Mo.). Sep 1972. Contract AT(29-1)-613. 48p. Dep. NTIS.

60774 (BDX-613-705(Rev.)) LOW-TEMPERATURE PROPERTIES OF GENERAL ELECTRIC LEXAN 8070-112 THIN POLY CARBONATE FILM. Final Report. Lazarus, L. J. (Bendix Corp., Kansas City, Mo.). Sep 1972. Contract AT(29-1)-613. 39p. Dep. NTIS.

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From Mid-America electronics conference; Kansas City, MO. (26 Oct 1972).

60776 (BNL-16603) PAPER-PLYWOOD: A PAPER POLYMER COMPOSITE (PPC). Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Feb 1972. 6p. Dep. NTIS.

60777 (BNL-16872) CLUSTERING ABOUT IONS: BOND ENERGIES, STRUCTURE, AND RELATIONSHIP TO EMBRYO FORMATION. Castleman, A. W. Jr.; Tang, I. N. (Brookhaven National Lab., Upton, N. Y.). May 1972. 7p. (CONF-720450-1). Dep. NTIS.

From International conference on nucleation theory; Atlanta, GA. (10 Apr 1972).

The processes of ion-induced nucleation include both molecula condensation about a central ion and particle formation via ion-molecule switching reactions. In the former, the ions provide a central force field, which is a simple form of attractive potentia resulting in the formation of heterogeneous embryos. A basic understanding of ion-induced nucleation, therefore, provides an important basis for further developments in the theory of hetero molecular nucleation which is initiated and enhanced by the pres ence of a foreign molecule in the nucleating phase. (auth)

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Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Sep 1972. Contract AT(04-3)-822. 16p. Dep. NTIS.

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60824 (ORNL-TIP/TIRC-72-36) MAMMALIAN EFFECTS OF NARCOTICS, NARCOTIC ANTAGONISTS, AND SUBSTITUTES. VI. NALOXONE. Warren, Helen S. (Toxicology Information Response Center, Oak Ridge, Tenn.). [nd]. 8p. Dep. NTIS.

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Germanic	ä appears as	ae
Germanic	ö	oe
Germanic	ü	ue
Scandinavian	ϕ	oe

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SUBJECT INDEX

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The reader is also referred to *Guide to Abstracting and Indexing for Nuclear Science Abstracts* (USAEC report TID-4576).

Most headings in the subject index are the names of specific materials, things, and processes. Each heading is followed by a modifier that describes the properties of, or processes applied to, that heading.

All index entries cite *NSA* volume and abstract numbers; volume number precedes the colon and the abstract number follows it. The designation (R) following the abstract number indicates a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Report numbers, where applicable, are included in parentheses after the abstract number of the citation. Published literature (journal article or book) can be identified by the absence of a report number.

Ideas presented in the original literature, rather than key words, have been indexed. The indexers have selected what seemed the most probable and logical place to look for typical information. Since it is not always possible to anticipate where a user would look for information, the cumulative indexes include numerous cross references. Consideration of synonymous or closely related terms will prove valuable.

Information is indexed for the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use or to the general class headings that include the specific headings. For example, information on boiler design for the Fermi Fast Breeder Reactor would be indexed under the headings BOILERS and FERMI FAST BREEDER REACTOR but not necessarily under the headings REACTORS, FAST or REACTORS, BREEDER.

General or broad headings are reserved for general summaries, reviews, comprehensive reports, and similar literature.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings; e.g., AMINO ACIDS rather than ACIDS, AMINO; HELIUM ISOTOPES He-4 rather than HELIUM—ISOTOPES He-4 or HELIUM—He-4 ISOTOPES. Note, however, that in some cases parenthetic modifying terms or inverted headings such as NEUTRONS, FAST, are used where the alphabetical arrangement of a direct entry would cause information to be scattered. In addition, organic compounds are usually entered in the index in the inverted form to facilitate grouping like or related compounds with the parent compounds; e.g., BENZENE, BROMO- rather than BROMOBENZENE.

Alphabetization

Subject headings are alphabetized word by word. Parenthetic qualifiers, numbers, and Greek letters within subject headings are disregarded in alphabetizing unless there are two or more headings that are otherwise identical, in which case the qualifier, numerical progression, or spelled names for the Greek letters determine the order.

Examples:

M-Capture
  see ELECTRON CAPTURE
MAGNESIUM
MAGNESIUM ALLOYS AND SYSTEMS
MESONS
MESONS (π)
MESONS (rho)
1-PENTANOL
2-PENTANOL
URANIUM OXIDES
URANIUM OXIDES UO_2

Modifying Phrases

The modifiers appearing under a subject heading are written specifically to show the relation between the item being indexed and the heading. The modifier therefore contains a maximum of useful information. Although the modifier begins with the word judged to be of greatest use to the greatest number of users, there is still need for the searcher to consider all modifiers under the heading(s) of interest.

Modifiers usually form meaningful phrases when combined with the subject heading. Some are intended to be read following the subject heading, e.g., the entry HYDROGEN—*sorption by charcoal,* should be read *hydrogen sorption by charcoal.* As a result of placing the important word first, however, many modifiers must be rearranged for smooth reading, e.g., FORMALDEHYDE—*yields in radiolysis of ethyl ether, effects of deuterium on,* should be read *effects of deuterium on formaldehyde yields in radiolysis of ethyl ether* and URANIUM—*crystal structure of, effect of cooling rate on allotropic transformations in,* should be read *effect of cooling rate on allotropic transformations in crystal structure of uranium.*

Special characters are added to modifiers in the fields of physics and reactor technology; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the abstract number.

Physical States and Configurations of Materials

The specific physical state, if other than normal, or the geometric configuration of the material is included in the modifying phrase; e.g., information on liquid metals is indexed under the specific metal with "liquid" in the modifier and carbon crucibles is indexed under CARBON with "crucibles" appropriately placed in the modifier. The information on carbon crucibles is also indexed under CRUCIBLES.

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed to subject headings in the direct form. Cations are listed in the order of increasing valence for polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., SODIUM ALUMINUM SILICATES and POTASSIUM SODIUM SULFATES. If more than one anionic species is presented in a compound, the anions are arranged alphabetically e.g., BERYLLIUM FLUORIDE HYDROXIDES.

Nomenclature of Organic Compounds

Complex organic compounds occur in such variety as to require a systematic nomenclature. Headings for most substituted organic compounds are found in an inverted form following names of the parent compounds. Examples of two such headings are:

```
2,4-HEPTANEDIONE
2,4-HEPTANEDIONE, 1-PHENYL-
```

Headings are included for broad class names of enzymes, e.g., HYDROLASES and TRANSFERASES. Specific enzyme names are to be found in modifiers under these headings. Similarly, broad class names for hormones are included as headings, except in this case the headings are entered in the inverted form as, e.g., HORMONES, ADRENAL and HORMONES, SEX. The more specific names of hormones are to be found in the modifiers under the appropriate broad headings.

For compounds used as drugs, an effort is made to use subject headings that reflect the recommendations of the USAN (United States Adopted Names) compilation or the "New Names" columns of the *Journal of the American Medical Association.* The *Merck Index* has also been used in selecting subject headings for drugs.

Nomenclature of Life Sciences

Except for those in the phylum Tracheophyta, subject headings for plants are common names. For example, ALGAE, FUNGI, SLIME MOLDS, MOSSES, and LIVERWORTS are subject headings. The phylum name TRACHEOPHYTA and several classes and subclasses belonging to it are entered as subject headings. The specific classes entered are PSILOPSIDA, LYCOPSIDA, SPHENOPSIDA, and PTEROPSIDA. The three subclasses FILICINIDAE, GYMNOSPERMIDAE, and ANGIOSPERMIDAE which belong under Pteropsida are also subject headings. Scientific names (genus and species) and common names if known are used in the modifying phrase.

Subject headings for microorganisms are VIRUSES, RICKETTSIA, and BACTERIA. The name of the type or kind of virus or the genus and species names of the organisms should appear in the modifying phrase.

The names of animal phyla are subject headings. The arthropods are also indexed to subject headings for classes INSECTA, CRUSTACEA, ARACHNIDA, DIPLOPODA, and CHILOPODA. The invertebrate chordates are indexed to subject headings UROCHORDATA and CEPHALOCHORDATA. The vertebrates are indexed to headings for the classes AGNATHA, CHONDRICHTHYES, OSTEICHTHYES, AMPHIBIA, REPTILIA, AVES, and MAMMALIA as well as to the general heading VERTEBRATA. Common names are used as subject headings in the class Mammalia.

Subject headings are entered for various classes of commodities, and specific products are identified in the file-word position of the modifier. In the following examples, approved subject headings are capitalized and typical modifier file words are listed in lower case.

Example 1	Example 2
CEREALS	MEATS
bread	beef
flour	fish
oats	mutton
rice	pork
rye	poultry
wheat	seafood

Diseases, pathological conditions, and in vitro studies of atypical cells and tissues are indexed under subject headings for the organism affected, under the appropriate anatomical structure of physiological phenomenon affected, and under the appropriate disease heading. Subject headings for diseases (defined as any deviation from the norm) are common names such as ANEMIA, FIBROSIS, INFECTIONS, LEUKEMIA, NEOPLASMS, and RADIATION SICKNESS. Also, the general headings DISEASES and DISEASES, PLANTS are available as subject headings.

Multicomponent Alloys and Other Systems

Multicomponent alloys and systems, except those with well-known trade names, are indexed under a subject heading for each component in the form "element systems" for nonmetals or "element alloys and systems" for metals. The modifier begins with element symbols for each component arranged alphabetically. In addition, if significance is placed on the base metal of the alloy, this is indicated by adding "-base" to the element symbol.

Example: A 1.5C, 12Cr, 0.25V, 0.8Mo, bal Fe alloy is indexed as

```
CARBON SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
CHROMIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
IRON ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
MOLYBDENUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
VANADIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
```

Well-known alloys, such as ZIRCALOY-2, are indexed under the trade name; cross references from each component of the alloy to the trade name appear in cumulative indexes.

Multicomponent systems in which nonmetallic elements are present in large percentage and which are commonly referred to as systems or mixtures are indexed in a manner similar to alloys.

Example: A tungsten–silicon preparation is indexed as

```
TUNGSTEN ALLOYS AND SYSTEMS
  Si--W, ...
SILICON SYSTEMS
  Si--W, ...
```

Multicompound systems and mixtures of inorganic compounds are indexed under the subject heading for each component compound; the modifiers begin with an alphabetical listing of compound formulas.

Example: A lead titanate–lead zirconate mixture is indexed as

LEAD TITANATES
$PbTiO_3$--$PbZrO_3$
LEAD ZIRCONATES
$PbTiO_3$--$PbZrO_3$

Mixtures of organic compounds are indexed under subject headings for each component of the mixture; the modifiers begin with an alphabetical listing of compound names.

Example:

ACETIC ACID
acetic acid--BF_3, ...
BORON FLUORIDES
acetic acid--BF_3, ...

Example:

BENZENE, CHLORO-
bromophenol--chlorobenzene, ...
PHENOL, BROMO-
bromophenol--chlorobenzene, ...

A mixed system of compounds and elements is indexed by a combined form of the preceding conventions; e.g., a dispersion of copper and alumina would be indexed as

ALUMINUM OXIDES
Al_2O_3--Cu, ...
COPPER ALLOYS AND SYSTEMS
Al_2O_3--Cu, ...

If modifiers for alloys and systems are included with other modifiers under the same subject heading, they are filed last.

Example:

CARBON SYSTEMS
deposition on nuclear fuel particles
molecular structure of
neutron total cross section for
sorptive properties for xenon
Young's modulus for
Al--C--Cr, superconductivity in
B--C, phase studies for
C--U--Zr, fabrication and physical properties of

Nomenclature of High Energy Physics

Information on particle-particle events is indexed under subject headings for the specific particles involved. The modifier file word *interactions* is followed by the specific interaction written in symbolic form. Particle nomenclature and symbols follow that of the Particle Data Group published in *Review of Particle Properties* (latest revision). For consistency the incident particle is always written first. The mass (in MeV) of a resonance state is included in parentheses after the symbol to avoid ambiguity. Hyperfragments are indicated in modifiers as in the following examples: Λ-He^5, Σ-H^3, $\Lambda\Lambda$-Be^{10}. The superscript on the right indicates the total number of baryons in the composite system.

Examples:

MESONS (π^-)
interactions $\pi^- + p \rightarrow \Lambda + K^+ + \pi^-$ at 6 GeV/c in hydrogen bubble chamber, ΛK(1700) enhancement in, (E)
BARYONS, RESONANCE (Δ)
production of Δ^{++}(1236) and Δ^0(1236) from $K^- + p \rightarrow K^- + p + \pi^+ + \pi^-$ interactions at 2.63 and 2.70 GeV/c, (E)
HYPERNUCLEI
binding energy of $\Lambda\Lambda$-He^6, three-body α--Λ--Λ model for

Subject headings are also provided for specific models and theories.

Examples:

ELEMENTARY PARTICLE MODELS
quark, hadron total cross sections in, numerical analysis of
CURRENT ALGEBRA
PCAC hypothesis for A_1 and rho dominance in $\pi \rightarrow e + \nu + \gamma$ decay
REGGE POLE THEORY
predictions for polarization in $K^- + p \rightarrow$ anti $K^0 + n$, $\pi^- + p \rightarrow \pi^0 + n$, and $\pi^- + p \rightarrow$ eta $+ n$ interactions at high energies
SYMMETRY GROUPS
SU(2) x SU(4) intermediate-coupling model for nucleon and hyperon isobars

Nomenclature of Reactor Technology

Subject headings for reactors are of three types:

(1) Specific reactors, e.g., ARGONNE RESEARCH REACTOR, SAXTON POWER REACTOR

(2) Reactors having a common physics or engineering characteristic, e.g., REACTORS, FAST; REACTORS, ORGANIC-COOLED; REACTORS, PRESSURIZED-WATER

(3) Reactors having a common purpose, e.g., REACTORS, POWER; REACTORS, RESEARCH

Information on specific reactors, type (1), is indexed under the one specific subject heading. Information on classes or types of reactors, types (2) (characteristics) and (3) (purpose), is indexed under all applicable headings. For example, information on a heavy-water-moderated organic-cooled power reactor is indexed under REACTORS, HEAVY WATER-MODERATED; REACTORS, ORGANIC-COOLED; and REACTORS, POWER.

Subject headings exist for selected reactor components, e.g., REACTOR FUEL ELEMENTS. When applicable, headings for components are indexed even though they may have been included in a modifier under a type (2) or (3) heading. The materials in reactor components are indexed when the information is peculiar to the material.

Modifier file words under reactor headings are of two primary types: one type expresses reactor characteristics, e.g., reactivity; the other, components, e.g., control rod. If no subject heading appears for a reactor component, the heading REACTORS is used, and the component is used as the modifier file word.

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3	26-60737	See FRNC-CONF-50
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CONF-720718-	(Symposium on The Physical Processes Responsible for the Dispersal of Pollutants in the Sea with Special Reference to the Nearshore Zone, Aarhus, Denmark, July 4-7, 1972)	
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64	26-60667	See DOCKET-50277-63
DOCKET-50280-	(Surry Power Station, See also DOCKET-50281) (Non-AEC)	
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61	26-60656	See DOCKET-50259-68
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66	26-60676	See DOCKET-50295-66
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73	26-60670	See DOCKET-50282-77
74	26-60671	See DOCKET-50282-78
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40	26-60664	See DOCKET-50272-40
41	26-60665	See DOCKET-50272-41
42	26-60623	See DOCKET-50272-42
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55	26-60702	See DOCKET-50324-54
56	26-60703	See DOCKET-50324-55
57	26-60704	See DOCKET-50324-56
58	26-60705	See DOCKET-50324-57
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